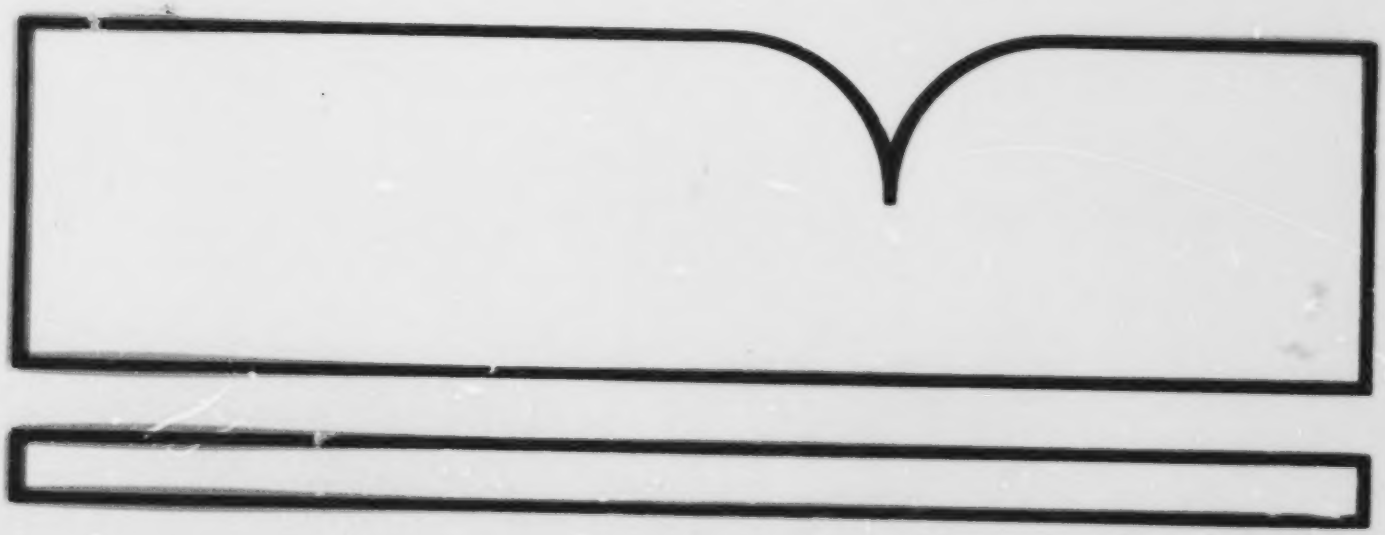
PB89-189468

Superfund Record of Decision (EPA Region 3): West Virginia Ordnance Works, Mason County, West Virginia (Second Remedial Action), September 1988

(U.S.) Environmental Protection Agency, Washington, DC

Sep 88



U.S. Department of Commerce
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United States
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Office of
Emergency and
Remedial Response

EPA/ROD/R03-88/053
September 1988

PB89-189468

EPA

Superfund Record of Decision:

West Virginia Ordnance, WV

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

The West Virginia Ordnance (WVO) site covers approximately 8,323 acres in Mason County, West Virginia. It is located on the east bank of the Ohio River. Almost one third of the site is occupied by a 2,788-acre wildlife station containing more than 30 snallow ponds created to promote a wetland/terrestrial habitat for various wildlife species. Estaolished in 1942, the WVO plant manufactured explosives, specifically TNT, from toluene. General Chemical Defense Corporation of New York operated the plant until 1945. Red and yellow water (liquid wastes) were produced during the TNT manufacturing process. Yellow water was discharged to the Mill Creek drainage system, which eventually drains into the Ohio River; red water was discharged directly to the Ohio River through a pipe located about one foot offshore. Retention ponds were constructed to regulate the discharge of red and yellow water to the river. TNT and associated by-products were burned onsite. In May 1981, ranger officials observed a seep of red water adjacent to a pond located on the wildlife station. Upon examination, ground water discharging to this pond was found to be contaminated by di- and trinitrotoluenes and phenol. Localized contamination of the snallow ground water and discharge to surface water have been documented in the vicinity of the TNT manufacturing area, the burning grounds, sediments of surface water receiving contamination, and former

(See Attached Sheet)

17. Document Analysis a. Descriptors

Record of Decision
West Virginia Ordnance, WV
Second Remedial Action - Final
Contaminated Media: gw, sediments, soil
Key Contaminants: lead

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

Availability Statement	19. Security Class (This Report) None	21. No. of Pages 62
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EPA/ROD/R03-88/053
West Virginia Ordnance, WV
Second Remedial Action - Final

16. ABSTRACT (continued)

wastewater storage lagoons. Evidence also indicates that soils of the industrial area, process facilities, and industrial wastewater facilities are contaminated by TNT and associated by-products (nitroaromatics). Based on the hydrogeologic setting of WVO, there is potential for contamination to migrate via surface water and/or ground water pathways to deeper layers of an underlying potable aquifer or to the Ohio River. Contaminant migration is possible toward the City of Point Pleasant and Camp Conlay community potable water supplies. The primary contaminants of concern affecting the soil, sediments, and ground water are nitroaromatics and lead.

The selected remedial action for this site addresses three distinct areas of contamination. These remedies include: Area 1 - purchase of contaminated land and control of land use, placing a soil cover over the contaminated area, and incorporating the area into the existing wildlife preserve; ground water pump and treatment to nitroaromatics criteria with discharge to surface water; monitoring discharge from the ground water treatment system to ensure compliance with the stream standards; and periodically inspecting and maintaining the soil cover in a stable condition. Area 2 - relocating ponds 1 and 2, filling them with clean material and covering them with a soil and clay cap; ground water pump and treatment to nitroaromatics criteria with discharge to surface water; and monitoring effluent from the treatment system to ensure compliance with surface water criteria. Area 3 - installing a soil cover over the West Well Area and the seep area; ground water pump and treatment to nitroaromatics criteria with discharge to surface water; monitoring effluent from the treatment system to ensure compliance with surface water criteria; and periodically inspecting and maintaining the soil cover in a stable condition. The estimated present worth for this remedial action is $3,365,000, with estimated O&M cost of $216,500.

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION FOR
SECOND OPERABLE UNIT

SITE: West Virginia Ordnance Works, Mason County, West Virginia

STATEMENT OF BASIS AND PURPOSE:

This decision document represents the selected remedial action for the West Virginia Ordnance Works Site, in Mason County, West Virginia, developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Plan Act of 1980 (CERCLA), as amended by the Superfund Amendment and Reauthorization Act of 1986 (SARA), 42 U.S.C. Section 9601 et seq. and the National Contingency Plan (NCP) 40 C.F.R. Part 300. This decision is documented in the contents of the items which comprise the administrative record upon which the selection of the remedial action is based. The State of West Virginia has concurred on the remedy.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy will provide protection of human health and the environment by containing soil/sediment contamination and eliminating further contamination of the groundwater aquifer. The ground water extraction system will remove contaminants from the groundwater and will improve groundwater quality.

There are three (3) distinct areas of contamination (Acids Area/Yellow Water Reservoir Area, Red Water Reservoir Area, and Pond 13/Wet Well Area) and the preferred remedy for each one is as follows:

I. Acids Area/Yellow Water Reservoir: Alternative 4A

- Purchase of lands within the industrial park encompassing the contamination, placing a soil cover over the contaminated area, incorporating the area into the existing wildlife preserve.

- Extracting and treating the ground water until the criteria for nitroaromatics are attained.

- Discharge from the ground water treatment system will achieve the stream standard and will be monitored to assure compliance.

- Soil cover will be periodically inspected and maintained in a stable condition.

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II. Red Water Reservoir: Alternative 4A

- Relocation of Ponds 1 and 2.
- Extracting and treating the ground water until the criteria for nitroaromatics are attained.
- Effluent from the treatment system will meet the surface water criteria and will be monitored to maintain compliance.
- Ponds 1 and 2 will be filled will clean fill (soil and clay cover).

III. Pond 13/Wet Well Area: Alternative 4A

- Soil cover will be installed over the Wet Well Area and the seep area.
- Extracting and treating the ground water until the criteria for nitroaromatics area attained.
- Effluent from the treatment system will meet the surface water criteria and will be monitored to maintain compliance.
- Soil cover will be periodically inspected and maintained in a stable condition.

DECLARATION

This selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate for this remedial action, and is cost effective. This remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element and utilizes permanent solutions and resource recovery technologies to the maximum extent practicable.

Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

9-30-88
Date

Stanley L. Laskowski,
Acting Regional Administrator
EPA Region III

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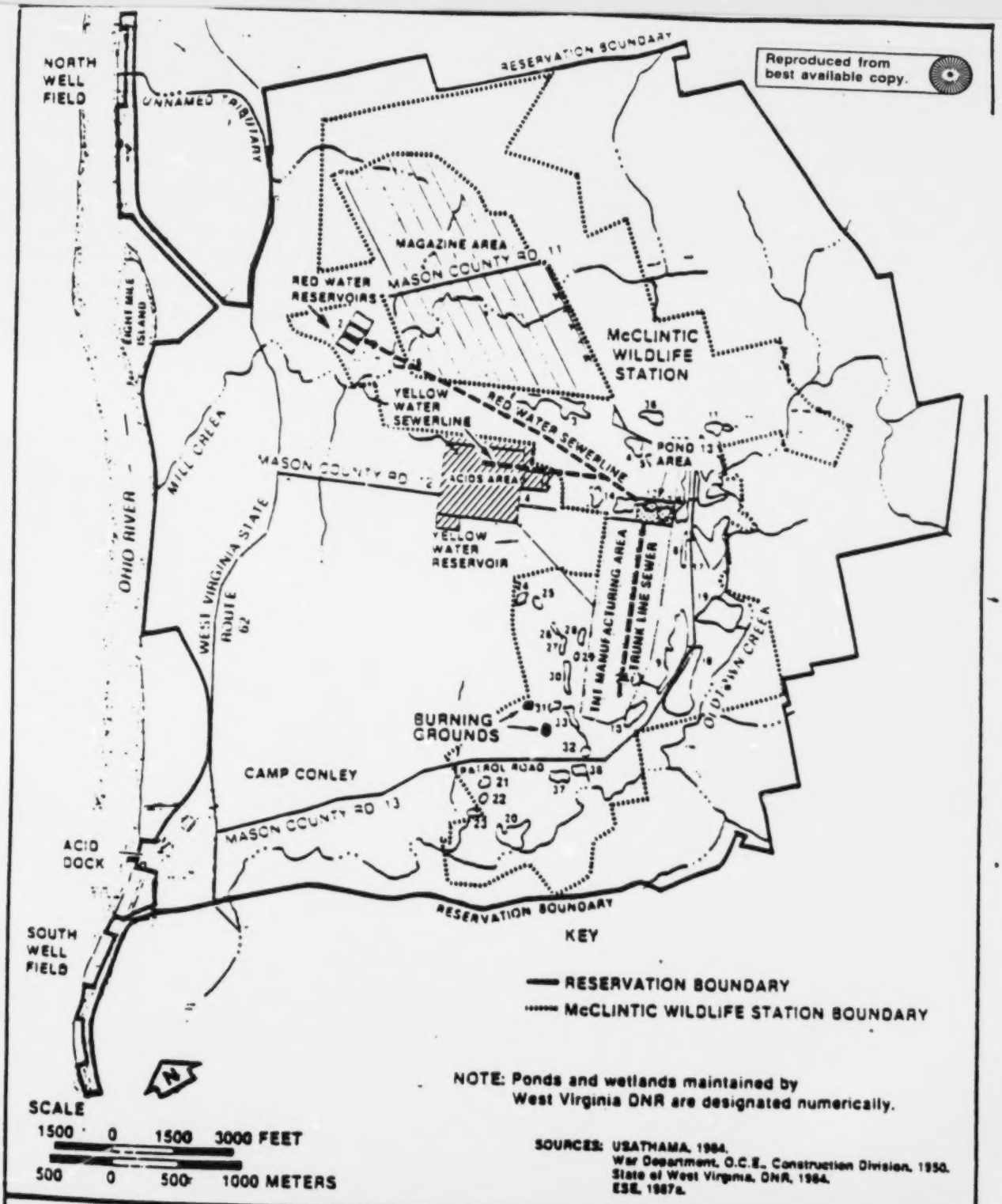

NOTE: Ponds and wetlands maintained by West Virginia DNR are designated numerically.

SOURCES: USATHAMA, 1984.
War Department, C.C.E., Construction Division, 1950.
State of West Virginia, DNR, 1984.
ESE, 1987a.

Figure 1
WVOW SITE LAYOUT

WEST VIRGINIA
ORDNANCE WORKS
Feasibility Study

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION FOR
SECOND OPERABLE UNIT

SITE: West Virginia Ordnance Works, Mason County, West Virginia

STATEMENT OF BASIS AND PURPOSE:

This decision document represents the selected remedial action for the West Virginia Ordnance Works Site, in Mason County, West Virginia, developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Plan Act of 1980 (CERCLA), as amended by the Superfund Amendment and Reauthorization Act of 1986 (SARA), 42 U.S.C. Section 9601 et seq. and the National Contingency Plan (NCP) 40 C.F.R. Part 300. This decision is documented in the contents of the items which comprise the administrative record upon which the selection of the remedial action is based. The State of West Virginia has concurred on the remedy.

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The selected remedy will provide protection of human health and the environment by containing soil/sediment contamination and eliminating further contamination of the groundwater aquifer. The ground water extraction system will remove contaminants from the groundwater and will improve groundwater quality.

There are three (3) distinct areas of contamination (Acids Area/Yellow Water Reservoir Area, Red Water Reservoir Area, and Pond 13/Wet Well Area) and the preferred remedy for each one is as follows:

I. Acids Area/Yellow Water Reservoir: Alternative 4A

- Purchase of lands within the industrial park encompassing the contamination, placing a soil cover over the contaminated area, incorporating the area into the existing wildlife preserve.

- Extracting and treating the ground water until the criteria for nitroaromatics are attained.

- Discharge from the ground water treatment system will achieve the stream standard and will be monitored to assure compliance.

- Soil cover will be periodically inspected and maintained in a stable condition.

V

II. Red Water Reservoir: Alternative 4A

- Relocation of Ponds 1 and 2.
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- Soil cover will be installed over the Wet Well Area and the seep area.
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- Effluent from the treatment system will meet the surface water criteria and will be monitored to maintain compliance.
- Soil cover will be periodically inspected and maintained in a stable condition.

DECLARATION

This selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate for this remedial action, and is cost effective. This remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element and utilizes permanent solutions and resource recovery technologies to the maximum extent practicable.

Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

9-30-88
Date

Stanley L. Laskowski,
Acting Regional Administrator
EPA Region III

Summary of Remedial Alternative Selection for Second Operable Unit at West Virginia Ordnance Works

A. Site Description

The West Virginia Ordnance Works (WVOW) site covers approximately 8,323 acres in Mason County, West Virginia. It is approximately 58 miles northwest of Charleston, 41 miles northeast of Huntington, and 6 miles north of Point Pleasant on the east bank of the Ohio River. Approximately one third of the area is currently occupied by the Clifton F. McClintic State Wildlife Station (McClintic Wildlife Station), which is 2,788 acres in size and operated by the West Virginia Department of Natural Resources (DNR) (Figure 1).

West Virginia DNR's management practices are primarily designed to promote a wetland/terrestrial habitat for populations of resident and migratory water fowl. Consistent with this objective, more than 30 shallow ponds have been constructed since cessation of military activities on the site in 1945. Most of the ponds are stocked with bass and catfish, and the area is open for public hunting and fishing. Smaller portions of the non-industrial areas of the site were declared excess by the Government, have been sold, and are now owned by Mason County or by private owners.

In May 1981, a seepage of red water was observed by ranger officials adjacent to Pond 13, located on the McClintic Wildlife Station. This incident was investigated by West Virginia DNR and the U. S. Environmental Protection Agency (EPA). The shallow ground water discharging to Pond 13 was found to be contaminated by 2,4-dinitrotoluene (2,4-DNT) (up to 7,100 micrograms per liter (ug/L)), 2,6 dinitrotoluene (2,6-DNT) (1,300 ug/L), 2,4,6-Trinitrotolune (TNT) (166 ug/L in one sample), and phenol (31 ug/L), all hazardous substances pursuant to CERCLA.

Based on these and other studies conducted by West Virginia DNR and EPA in 1981 and 1982, WVOW was ranked as the 84th site on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) 42 U.S.C. Section 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), Pub. L. No. 99-499, 100 Stat. 1613.

B. SITE HISTORY

WVOW was established in 1942 as a Government-owned, contractor-operated plant for the manufacture of explosives from toluene. General Chemical Defense Corp. of New York (a subsidiary of General Chemical Co., which was a subsidiary of Allied Chemical and Dye Corp.) operated the plant under contract with the Federal Government. Prior to establishment of the plant, the major land uses were for crops (approximately 50 percent of the area), forest, pasture, and approximately 30 farm residences. Camp Conley, a West Virginia National Guard site established in 1927, was the acquisition for the plant.

From 1942 to 1945, WVOW operated to produce TNT, an explosive for the war effort. Production of this material during World War II (WWII) resulted in contamination of the soils of the industrial area, process facilities, and industrial wastewater disposal facilities by TNT and associated by-products. TNT was shipped to various Government installations to be loaded into munitions or for other uses. No loading of munitions or testing of ordnance was conducted at WVOW.

Red and yellow water are liquid wastes produced during the TNT manufacturing process. Yellow water was discharged to the Mill Creek drainage system, which eventually drains into the Ohio River; red water was discharged directly to the Ohio River through a pipe located about 1 foot offshore. Retention ponds, shown as the Red Water Reservoirs and Yellow Water Reservoir in Fig. 2, were constructed to regulate the discharge of red and yellow water to the river. Off-specification TNT was taken to the Burning Grounds (see Fig. 2) for destruction by burning. Surface and subsurface soils and groundwater in areas of WVOW are still contaminated with nitroaromatic residues. In addition, a potential exists for contamination of other areas due to post-operation contaminant migration.

At the close of operations in 1945, WVOW was decontaminated, and was subsequently declared surplus and the facilities salvaged or disposed. No records currently exist regarding the general extent of this decontamination effort. The industrial portion of the site was deeded to the State of West Virginia, with the stipulation that the site be used for wildlife management. If the land were to be used for any other purpose, or in the event of national emergency, the ownership of the land would revert to the Federal government.

In May 1984, after the site was listed on the NPL, EPA concurred with the Army's request to assume responsibility for response actions at WVOW. In October of that year, Environmental Science and Engineering, under contract to the Army, began work on a Remedial Investigation. In January, 1985 it was decided by EPA and DOD that the RI/FS should be conducted in two phases or operable units. The first operable unit addressed the sources of contamination, while the second operable unit concerned groundwater. The Phase I RI/FS was completed in July 1988. The remedial action for the first phase Operable Unit was published in a Record of Decision (ROD) in March 1987. That ROD required:

1. In situ flaming of reactive TNT residue on the surface of the Burning Grounds Area followed by the installation of a 2 ft. soil cover over areas with greater than 50 ppm total nitroaromatics.

2. Installation of a 2 ft. soil cover over areas in the TNT Manufacturing Area with greater than 50 ppm total nitroaromatics.

ATTENTION

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DIRECT QUESTIONS RESULTING FROM ILLEGIBILITY TO:

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3. Disposal of asbestos from the Burning Grounds Area at an approved of-site facility.

4. Excavation of reactive sewerlines, flashing, and backfilling of trenches from which they were removed. All contaminated soil exceeding 50 ppm at the surface was to be covered to achieve a 10^6 cancer risk level.

5. Performance of a wetlands assessment prior to construction activities.

An Interagency Agreement between EPA and the Army for the Army's implementation of the above activities was signed in September 1987. To date, all of the aforementioned activities have been completed.

This ROD addresses the second operable unit, or the groundwater, at the WVOW site. In August 1987, the final RI and EA for the second operable unit was received by EPA,. was received in EPA on October 1987.

Based on the hydrogeologic setting of WVOW, the potential exists for contamination at WVOW to migrate via surface water and/or ground water pathways to the deeper layers of the aquifer or to the Ohio River. Contaminant migration is possible toward the city of Point Pleasant and Camp Conley community potable water supplies.

Contaminants most likely to migrate beyond the former installation boundaries and/or to present the most serious threat of environmental degradation and threat to human health are nitroaromatic residues [2,4,6-TNT, 2,4 dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), and other TNT manufacturing by-products] remaining as a result of WVOW explosives production. Many of these compounds are toxic and/or suspected human carcinogens and are persistent in the environment. Localized contamination of the shallow ground water and discharge to surface waters have been documented in the vicinity of the TNT Manufacturing Area, the burning grounds, the sediments of the surface waters receiving contamination, and the former wastewater storage lagoons. Table 1 and Figure 2 provide a summary of contaminants and concentrations for the three source areas evaluated in this operable unit.

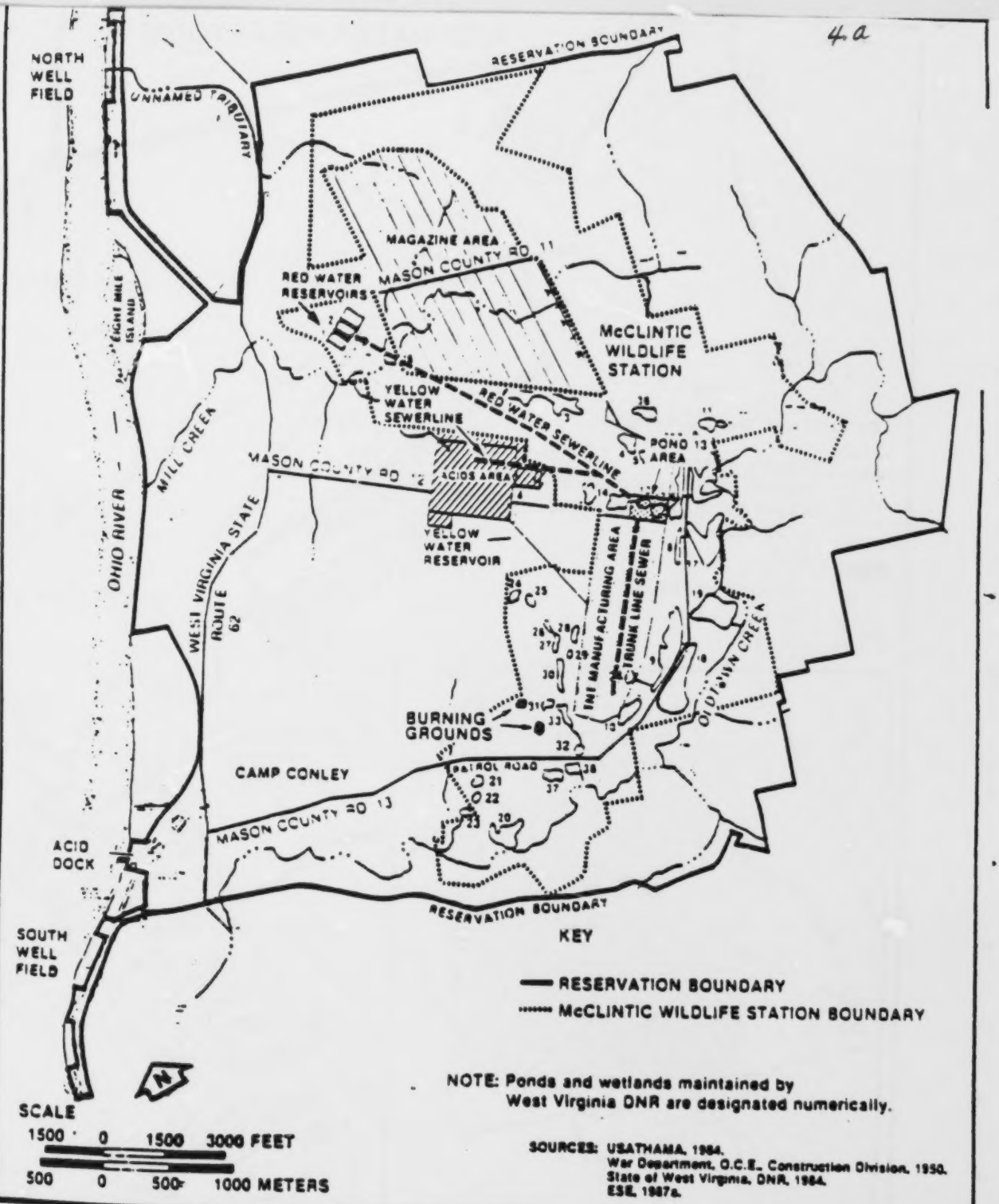
For the purpose of clarification, when general reference is made to the explosive, such as in Fig. 2, which describes the TNT Manufacturing Area, it is referred to as TNT, the common acronym. In this document, specific references to the chemical compound which is actually 2,4,6-trinitrotoluene, and its environmental concentration, use the acronym 2,4,6-TNT. References to concentrations of unspecified chemical mixtures of byproducts of 2,4,6-TNT manufacture are termed nitroaromatic compounds.

Table 1. Summary of Contamination Status for the Second Operable Unit

Environmental Medium	Contaminant	Maximum Concentration Detected*
Acids Area/Yellow Water Reservoir		
Soils	2,4,6-TNT	1 percent (isolcated area approximately 100 ft.)
	Lead	100 ug/g
Ground Water	Nitroaromatics	60 ug/L
Red Water Reservoirs		
Sediments	Nitroaromatics	2,210 ug/g
Ground Water	Nitroaromatics	100 ug/L
Pond 13/Wet Well Area		
Surface Water	Nitroaromatics	68 ug/L
Sediments	Nitroaromatics	4,240 ug/g
Ground Water	Nitroaromatics	50,000 ug/L

* In each area, sampling strategy in the RI was designed to identify and sample the most contaminated areas, so the maximum concentrations are not necessarily representative of the typical concentration in each source area. In virtually all source areas, several samples were collected that were uncontaminated thus realistically defining the extent of contamination.

Note: ug/g = micrograms per gram.



NOTE: Ponds and wetlands maintained by West Virginia DNR are designated numerically.

SOURCES: USATHAMA, 1984.
War Department, C.C.E., Construction Division, 1950.
State of West Virginia, DNR, 1984.
ESE, 1987a.

Figure 1
WVOW SITE LAYOUT

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

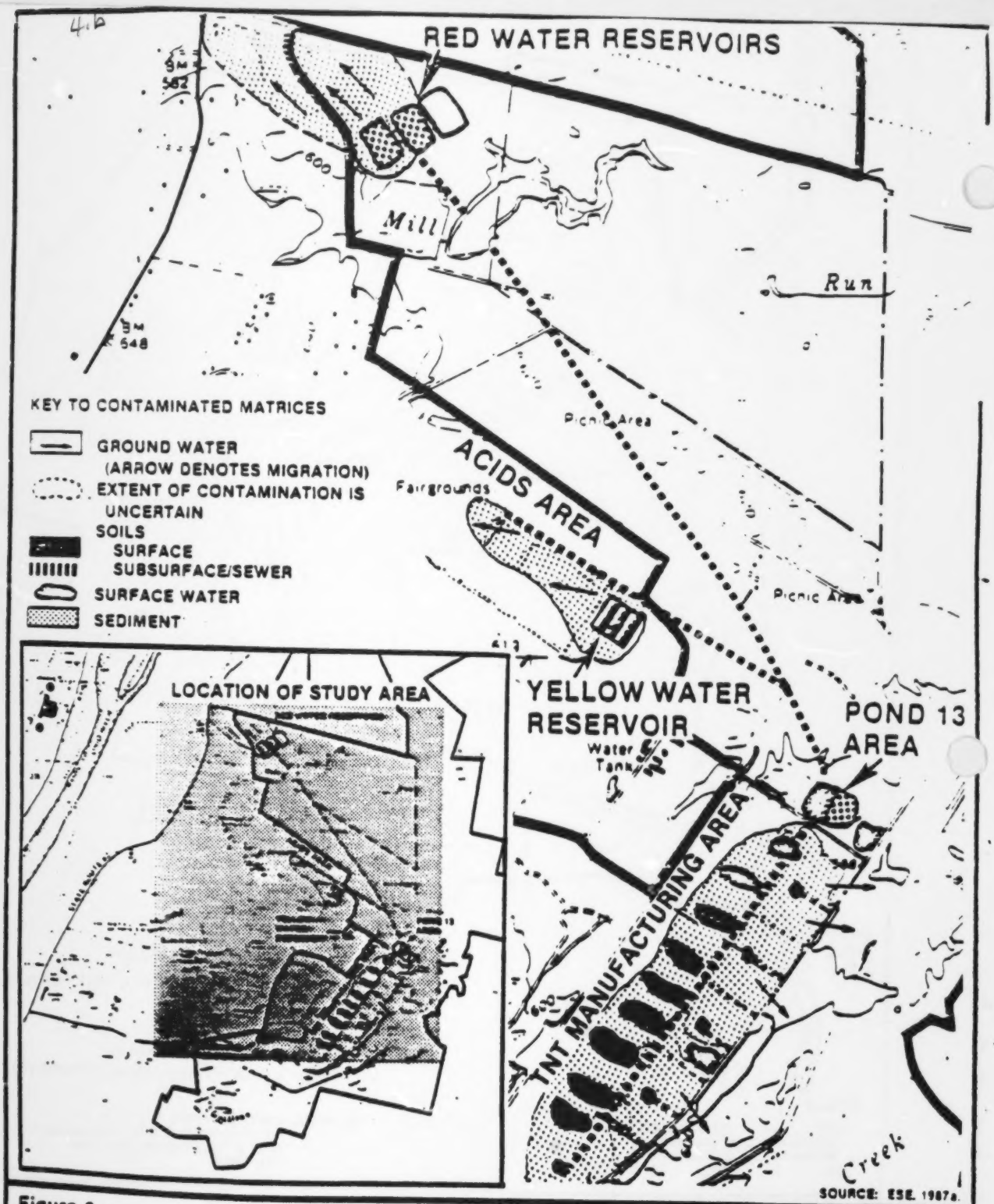


Figure 2
CONTAMINATION SUMMARY AT SECOND OPERABLE UNIT

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

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C. SITE CHARACTERISTICS

1. Surface Hydrology

During the period of operation in the 1940s, WVOW was drained by two major streams, their tributaries, and a number of intermittent streams (see Fig. 3). The northern half of the installation, including the magazine area and the acids area, was drained by Mill Creek and a small, unnamed tributary. Mill Creek is a tributary to the Ohio River and enters the river along the western boundary of the installation. The Ohio River is located adjacent to the installation, along the western boundary near the administration area and along the north and south well fields. As shown in Fig. 3, the southern and eastern sections of the installation were drained by Oldtown Creek. This stream and a number of smaller tributaries drained the TNT Manufacturing Area. Oldtown Creek is also a tributary to the Ohio River and contributes to the river south of the installation.

Three surface impoundments, called the Red Water Reservoirs, were located in the northwest section of the installation. These reservoirs had a total capacity of 30 million gallons (MG). A small reservoir, called the Yellow Water Reservoir, was located adjacent to the Acids Area. This reservoir had a capacity of 5 MG. A smaller water recovery reservoir was located in the TNT production area; the capacity of this reservoir is unknown.

A number of manmade surface water features were constructed subsequent to closure of the installation in 1945. Thirty-nine ponds are currently located at the McClintic Wildlife Station (see Fig. 4). Most of these ponds were created between 1953 and 1975 by the construction of impoundments and water control structures (e.g., dams and weirs) along the various drainage ways. The ponds were constructed to provide wetland habitats for various wildlife species. Currently, two of the three Red Water Reservoirs contain standing water; the northern most reservoir is empty and has revegetated. The Yellow Water Reservoir that was present in 1945 was filled shortly after the installation closed in the mid 1940s, and the small water recovery reservoir located in the TNT Manufacturing Area was removed prior to 1975. Natural drainage by Mill Creek and Oldtown Creek has remained similar to the drainage during the 1940s, except for alteration of a number of tributaries due to pond construction.

2. Site Geology

WVOW is located in the Ohio River basin, which consists of Pennsylvanian-age rocks overlain by quaternary alluvium. The rocks underlying the installation are part of the Parkersburg syncline. The synclinal axis is located approximately 20 miles southeast of WVOW and has a northeast-southwest orientation. The oldest exposed rocks are Pennsylvanian in age and crop out along stream valleys. Fig. 5 shows a generalized geologic cross section across WVOW as developed by Wilmoth (1966). Crystalline basement occurs between 9,000 ft. and 11,000 ft. below the Mississippian age rocks.

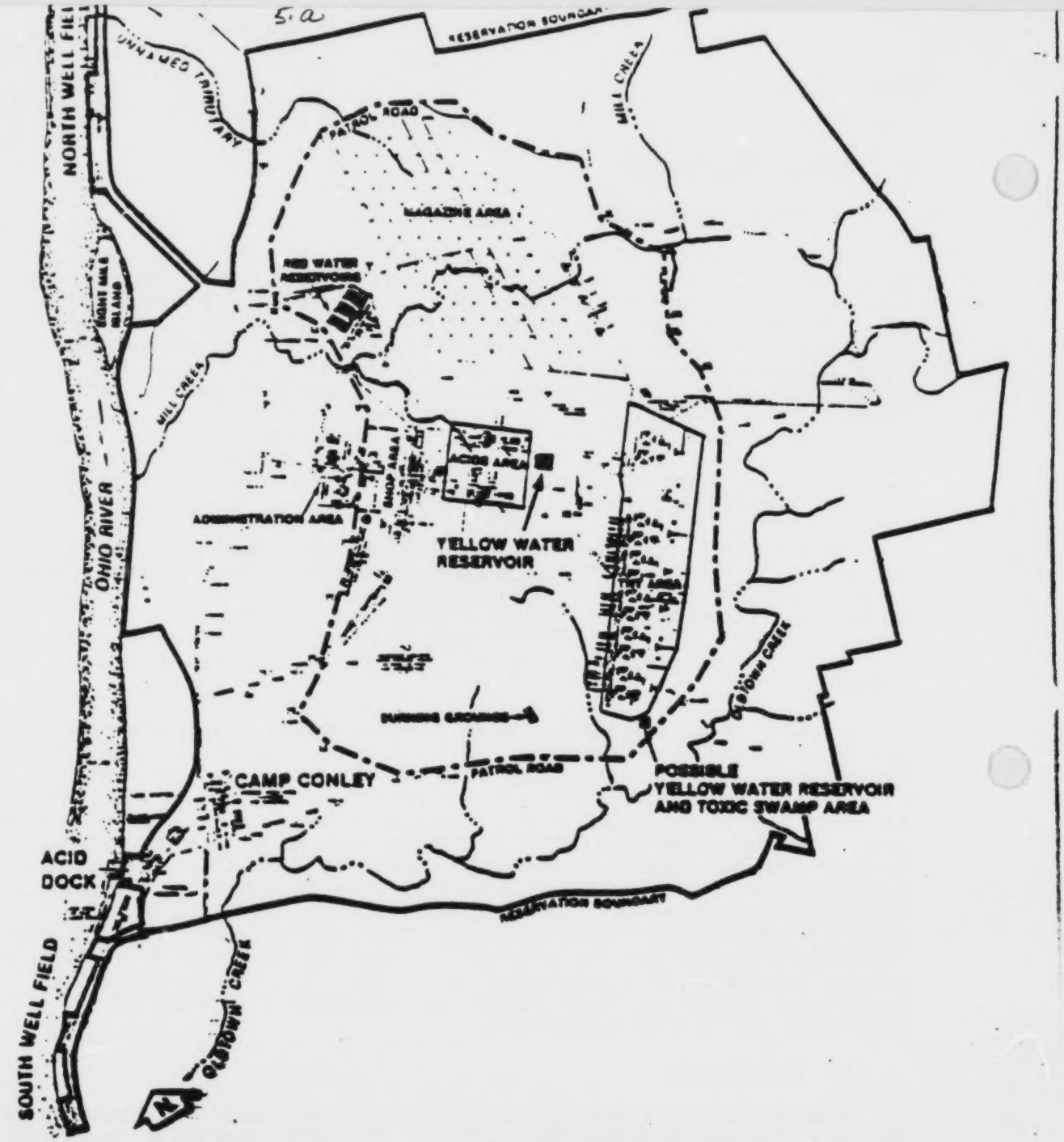

Figure 3,
SURFACE HYDROLOGY AT WVOW (1942)

WEST VIRGINIA
ORDNANCE WORKS
Remedial Investigation

The Mississippian System includes the Pocono and MacCrady Formations overlain by the Greenbrier and Mauch Chunk Groups. The Pocono Formation consists of mostly coarse-grained sandstone and sandy shale, with a thickness of between 480 ft. and 580 ft. The MacCrady Formation is a shale unit, with an approximate thickness of 50 ft. The Greenbrier Group primarily consists of limestone, with some thin units of shale and sandstone. This group has a thickness of between 100 ft. and 215 ft.; wells screened in this unit produce a non-potable saline. The Mauch Chunk Group consists of sandstone and shale units, with a thickness of up to 80 ft. Wells in this unit also produce a saline water, with a yield of around 1 gallon per minute (gpm).

The Pennsylvanian System includes the Pottsville, Allegheny, Conemaugh, and Monogahela Groups. These units have a combined thickness of between 260 ft. and 955 ft. and were deposited in a freshwater environment; all the groups contain carbonaceous deposits. The Pottsville Group is the basal unit of the Pennsylvanian System. The unit consists of coarse-grained sandstone, with thin beds of coal, shale, and clay. The formation is between 185 ft. and 250 ft. thick in the vicinity of WVOW. The Allegheny Group does not crop out in Mason County and is encountered only in subsurface borings. The Conemaugh Group overlies the Allegheny Group and has a thickness of between 480 ft. and 600 ft. The group consists of alternating sandstones, shales, and limestones, with some coal and clay units. The youngest Pennsylvanian unit is the Monogahela Group; this group also contains alternating shales, sandstones, and coal. The cross section (see Fig. 5) from Wilmoth's (1966) ground water study shows the bedrock to be part of the Conemaugh Group; however, the geologic map from the same study indicates that rocks of the Monogahela Group underly the area. Rocks from both of these groups are primarily clastic with minor amounts of limestone and coal. The Conemaugh Group contains a larger percentage of sandstone than the Monogahela Group, and both groups contain siltstones and shales. Thickness ranges from 230 ft. to 320 ft; these units form the upland areas on the eastern side of WVOW.

Overlying the Palezoic rocks at WVOW is an alluvial unit that reaches thicknesses of up to 185 ft. The alluvium is found as river floodplain deposits, and elevated terraces along the Ohio River were deposited as glacial outwash to the south of the Wisconsin continental ice sheet. The alluvial deposits overlying bedrock to the east and northeast of WVOW were deposited in the channel of a preglacial river that flowed southward from Ohio through northern Mason County and then westward back into Ohio. The alluvium consists of a basal gravel-sand unit and increases in coarseness from top to bottom, with a clay and silt floodplain near land surface. (Fig. 7), shows a generalized cross section of these upper geologic units.

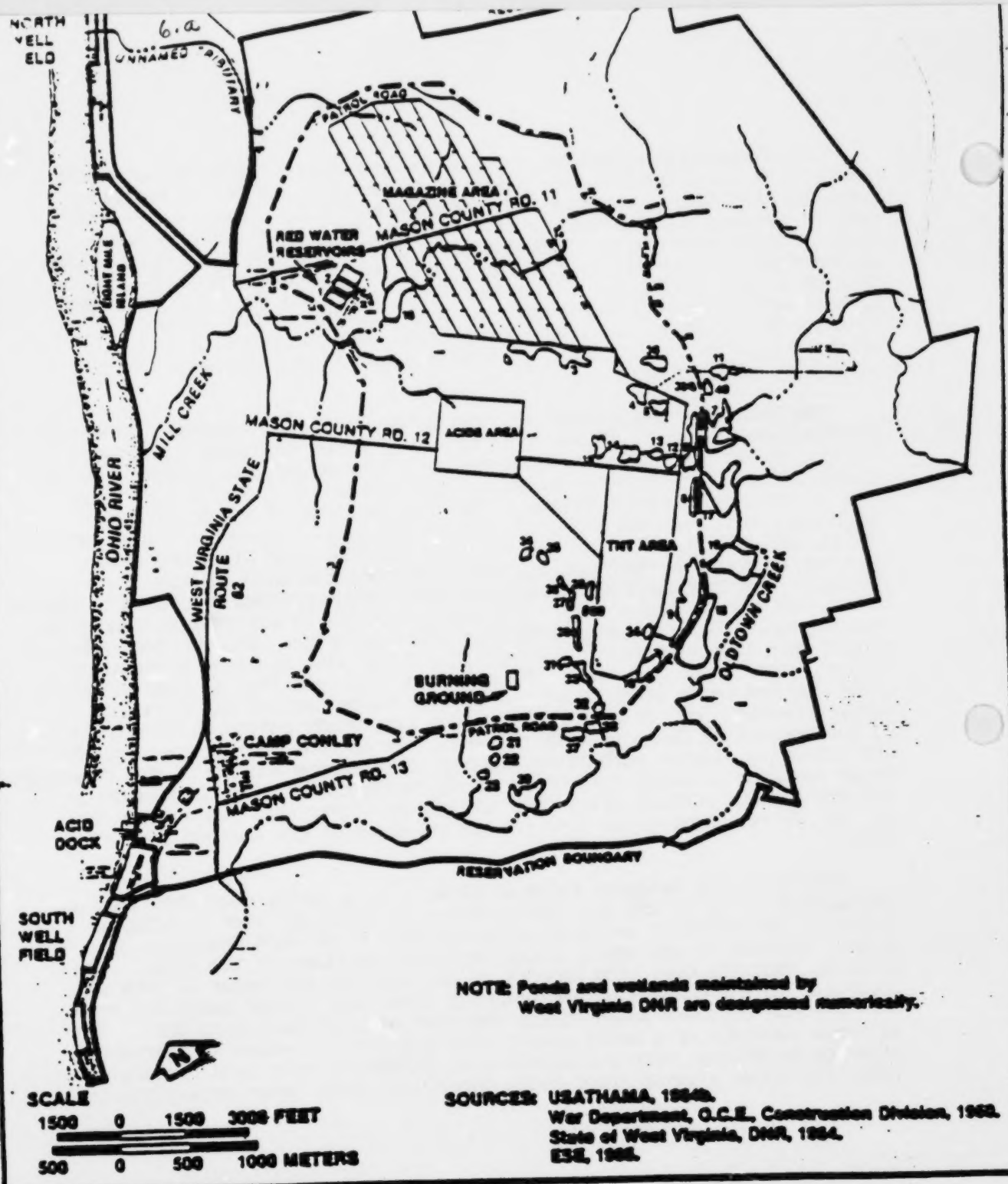

Figure 4. SURFACE HYDROLOGY AT THE WVOW SITE (1985)

WEST VIRGINIA ORDNANCE WORKS
Remedial Investigation

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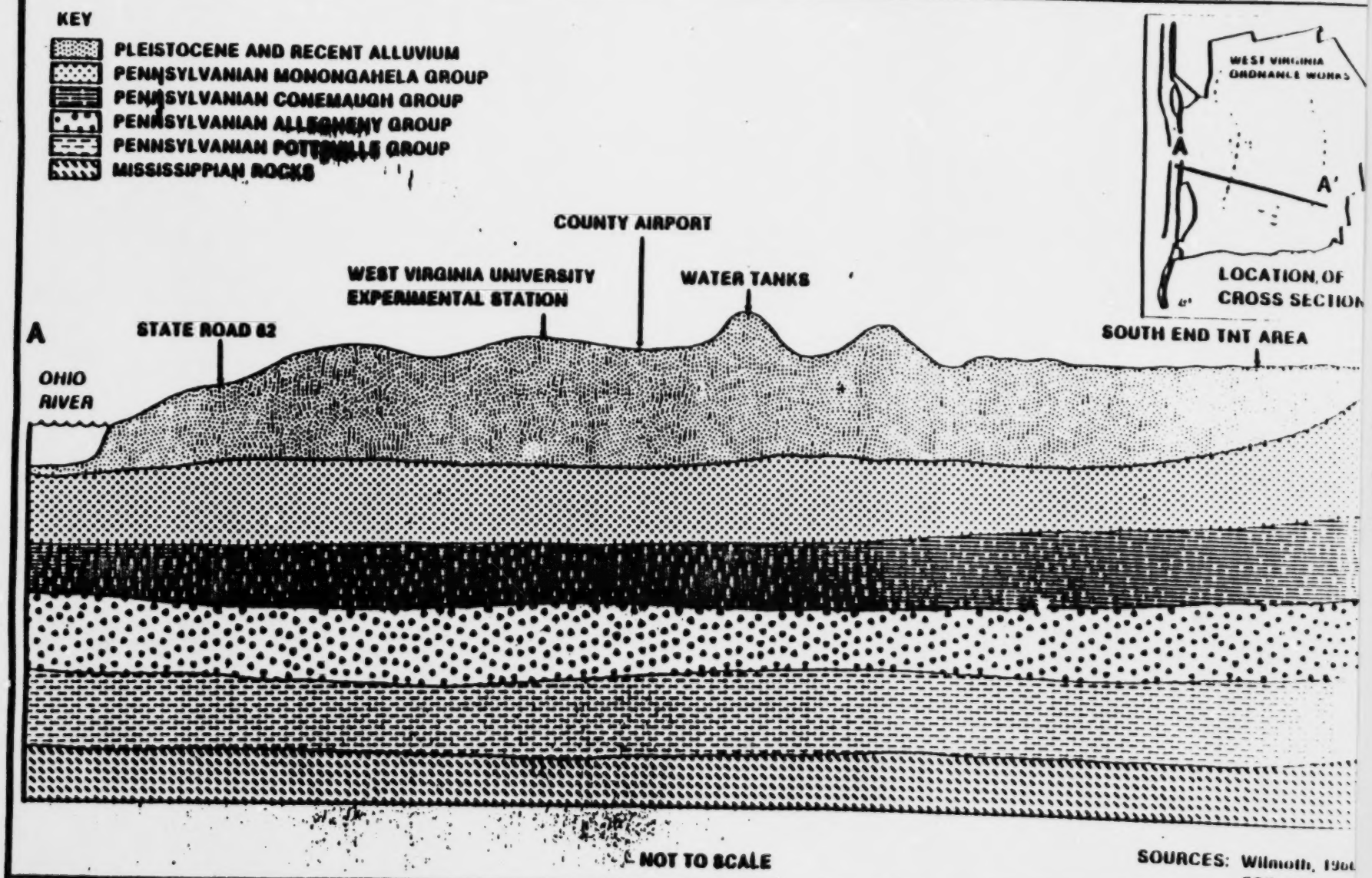


Figure 5.
GENERALIZED GEOLOGIC CROSS SECTION THROUGH THE OHIO RIVER

WEST VIRGINIA ORDNANCE WORKS

The 1966 Wilmoth study was produced from a limited database addressing the immediate vicinity of WVOW and was directed primarily toward defining and delineating potable ground water supplies in Mason County. The major aquifer of concern was the productive glacial outwash sediments immediately overlying the bedrock. The shallow alluvial aquifer at WVOW would not have been considered an important potable water supply aquifer and may not have been detected or adequately defined in the 1966 study. The water table shown in Fig. 7 represents the interpreted potentiometric surface of the aquifer, which was assumed to be in hydraulic communication with the Ohio River.

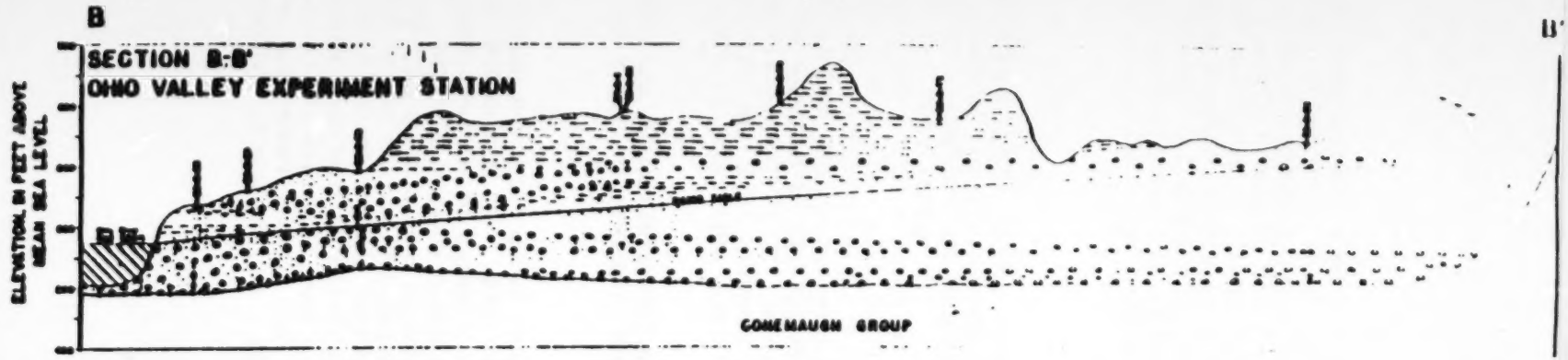
3. Site Soils

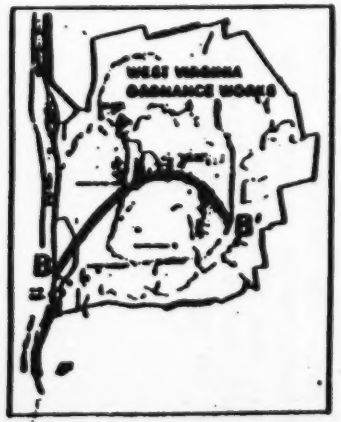
The U. S. Soil Conservation Service (USSCS) (1961) mapped and identified the soils at WVOW. Two regional soil associations are present on the installation along the Ohio River bottomlands and terraces; the Aston, Wheeling, and Lakin Associations are predominant. The upland areas can be grouped into the Muskingum, Upshur, and Vandalia Associations. The bottomlands and river terrace deposits consist of alluvial soil, with a thin veneer of recent river silt and clays. The upland soils consist of material weathered from the underlying bedrock, mostly sandstone, shales, and siltstone. A third major soil type consists of mixed amounts of alluvium and sediment disintegrated from the underlying bedrock. These mixed soils are located on upland terraces and consist of the Wheeling soil type on well-drained areas and the Sciotoville, Ginat, and Chilo soil types on the poorly drained areas.

Detailed soil locations, drainage characteristics, and permeabilities were determined by USSCS (1961) and are presented in Fig. 8 and Table 2.

4. Site Groundwater

Generally, Monogahela and Conemaugh Groups form the deep potable Pennsylvania aquifer system underlying WVOW. The Monogahela Group yields enough water for domestic supply from a number of porous sandstone units. Well yields range from 1 to 25 gpm, with an average of 9 gpm. The Monogahela contains less sandstone than the Conemaugh and is situated topographically higher. These factors make the Conemaugh aquifer the better water-bearing formation. The Conemaugh is the principal aquifer to the south of WVOW in the Kanawha River Valley. Most wells that draw from this aquifer are for domestic and farm supplies, although a few industrial and public supplies tap this formation. Well yields for this aquifer range from less than 1 gpm to 102 gpm and average about 9 gpm. Transmissivity and storage coefficients





LOCATION OF CROSS SECTION

KEY
- CLAY AND SILT
- SAND
- SAND AND GRAVEL

SCALE

600 0 600 1,200 FEET

200 0 200 400 METERS

SOURCES: Wilmoth, 1966
ESE, 1985

Figure 7
GEOLOGIC CROSS SECTION OF THE
[illegible]

WEST VIRGINIA
ORDNANCE WORKS
Remedial Investi[illegible]on

Figure 8-
SOILS MAP OF THE
WVOW SITE

WEST VIRGINIA
ORDNANCE WORKS
Remedial Investigation

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7.C

Table 2. Soil Types Within the WVOW Site

Soil Type	Soil Description	Drainage	Permeability
As	Ashton Silt Loam	Well Drained	Moderate-Rapid
ChA	Chilo Sandy Loam	Poorly Drained	Slow
Du	Duncannon Silt Loam	Well Drained	Moderate
GsA	Ginat Silt Loam	Poorly Drained	Very Slow
Ha	Hackers Silt Loam	Well Drained	Moderate
Hu	Huntington Silt Loam	Well Drained	Moderate
La	Lakin Loamy Fine Sand	Excessively Drained	Rapid
Ma	Markland Silty Clay Loam	Moderately Poorly Drained	Slow-Very Slow
Me	Melvin Silty Clay Loam	Poorly Drained	Moderate Slow-Very Slow
Mg	Monongahela Silt Loam	Moderately Well Drained	Slow
Mo	Moshannon Silt Loam	Well Drained	Moderate
Mu	Muskingum-Upshur Silt Loam	-	Moderate
Sc	Sciotoville Silt Loam	Moderately Well Drained	Moderate-Slow
Se	Senecaville Silt Loam	Moderately Well Drained	Moderate-Slow
So	Sloping Land	-	-
Uc	Upshur Clay Loam	Well Drained	Slow-Very Slow
Um	Upshur-Muskingum Clay Loams	-	-
Va	Vandalia Clay Loam	Well Drained	Moderate-Slow
Wn	Wheeling Fine Sand Loam	Well Drained	Moderate-Rapid

coefficients calculated from aquifer tests show a wide range of values, depending on the zone of production and lithology encountered. The lower units of the aquifer yield saline water in some sections and are not suitable for domestic or public usage. Aquifer tests in the Pennsylvanian rocks, where overlain by alluvium, commonly show some indication of hydraulic connections between the bedrock and the alluvium and/or the river. Water levels recorded in the alluvial and Pennsylvanian aquifers have shown variable head differences between the potentiometric surfaces of the two aquifers. Vertical gradients developed in the vicinity of WVOW show head differences as great as 30 ft. Much of the ground water encountered in the deeper aquifer system is presumed to occur in joint-openings, along bedding planes, and in the rock's pore space.

Site-specifically, a number of distinct hydrogeologic flow systems were characterized at WVOW. In the Acids Area/Yellow Water Reservoir, the shallow aquifer consists of a mediumto-coarse-grained sand containing approximately 5 to 10 percent gravel. This sand is overlain by a silty clay layer varying in some areas to clay and ranging in thickness from approximately 10 to 15 feet. The sand aquifer is uniform in texture and gradation throughout the area. Two apparently discontinuous clay and silty clay layers were observed in monitoring wells screened in the shallow aquifer beneath the Acids Area/Yellow Water Reservoir area. The clay layers do not form a continuous confining layer, and the sand aquifer exists in an unconfined or semi-confined state. In deep monitoring wells drilled at the adjacent north and south powerhouses, a gray clay with textural and physical characteristics similar to the gray clay confining layer observed in the first operable unit TNT Manufacturing Area and Burning Grounds Area was encountered.

At the Red Water Reservoirs, surface sediment consists primarily of silty clay extending to a 10 to 15 ft. depth. At two of the monitoring wells, the clay is overlain by a medium-grained sand. A second sequence of clays and silty clays is present and varies in thickness from 2 feet to 20 feet. As shown in the geologic cross section for the Red Water Reservoirs, a high degree of lithologic variation (both areally and vertically) is present at this area of concern. Sand and clay units are both generally discontinuous over this area of concern with the exception of one continuous water-bearing sand unit (the shallow alluvial aquifer) at elevation 580 feet above mean sea level (ft-MSL).

In and around the Pond 13/Wet Well Area, two markedly different hydrogeologic environments exist. At Pond 13, near-surface sediments consist of a thin veneer (5 to 10 ft.) of sandy, silty clay underlain by a thin clay layer, the areal extent of which is unknown. A second sand layer occurs below this clay layer; below this second sand layer, interbedded fine-grained sediments are present. In contrast, the sediments encountered at nearby wells indicate a markedly different hydrogeologic environment. At these wells, the first permeable zone was not encountered until 526 ft-MSL, approximately 60 ft. below ground surface. The gray clay confining layer is present beginning at 560-ft MSL and extending 25 ft. in thickness. The distance between the two monitoring wells is approximately 300 ft. The actual boundary between these two lithologic and hydrogeologic environments is not known.

In the deep monitoring wells drilled throughout the site, the majority of wells were screened in sediments of alluvial origin. Several wells encountered glacial outwash material, and according to published information (Wilmoth, 1966), the glacial outwash aquifer represents a single, continuous aquifer system. However, given the limited number of wells which penetrated the glacial outwash aquifer throughout the site during the Phase I investigation, it was not possible to verify this information.

5. Ground Water/Surface Water Interation

The interaction of ground water flow systems with surface water flow throughout the site was assessed in the initial RI survey by the use of a stream gaging program coupled with information obtained from selected monitoring wells installed adjacent to surface water drainage flow systems. For those areas on the site with adjacent surface water gaging stations and monitoring wells, comparison was made between surface water station elevations (from staff gage data) and the first permeable layer encountered during monitoring well drilling. These data that were developed indicate that the range of surface water elevations varies less than 3 ft. throughout the study.

The hydrologic interconnection present from the intersection of surface drainage with the permeable strata at these portions of the site suggests that, as ground water elevation increases, a significant ground water component should be present in flows observed in Mill Creek. In most ponds at the site, ground water discharge into the ponds or recharge by the ponds into the ground water is substantially minimized by the presence of extensive clay deposits in the pond bottoms. Sediment grab samples (approximately 6 to 8 inches in depth) and sediment core samples (1 to 3 feet in depth) in the ponds consisted primarily of stiff clay with a thin, overlying layer of decomposed, organic, detrital material. In many cases, field observations indicated that the bottom portion of even the shallow (6

to 8-inch) core ranged in moisture content from dry to slightly moist, whereas sediments in the top 1 to 2 inches of the core were wet. During the October 1984 gaging, no surface water outflow was occurring from any of the ponds. Because of the lack of interconnection with the ground water, the potential for input to or output from the ponds is generally small. However, rising ground water levels and surface runoff during a wet season greatly increase the potential for ground water discharge to the northern ponds.

In the northern portions of WVOW, the Mill Creek flow system receives ground water discharged during high-flow conditions. The Mill Creek stations are downstream from both a treatment plant and Pond 16. Pond 16 is located immediately upgradient of the Red Water Reservoirs. The results of the Phase I RI study indicate that Pond 16, through leakage, recharges the shallow aquifer at the Red Water Reservoirs.

The gravel and sand lenses in the glacial alluvium constitute the principal aquifer at WVOW. These deposits are the most productive ground water units, with a high hydraulic conductivity and fairly high well yields. The water table in Mason County was reported to range from about 10 to 90 ft. below land surface. At the WVOW site, the level at which ground water may be encountered was expected to range from 5 to 45 ft. below land surface. Recharge to the alluvial aquifer consists of infiltration of precipation, movement of ground water from the bedrock to the alluvium, seepage from small streams flowing across the terrace deposits, and recharge from the Ohio River during periods of high stage or flooding. Industrial and public-supply wells in the area have an average yield of 200 gallons per minute)gpm) according to Wilmoth (1966). WVOW radial collectors located adjacent to the Ohio River ranged from 1,245 to 1,918 gpm, with a 1,565-gpm average. Aquifer tests on a number of municipal well fields in the alluvium indicated moderately good transmissivity and watertable storage. Based on historical well construction information and water level data available prior to the RI, a ground water divide appeared to exist, most likely in the area of the TNT production lines. Because of the lack of well location and water level data from the northeastern portion of WVOW, the exact location of the probable divide could not be determined. However, due to the localized nature of the contamination this does not appear to present a problem. Ground water in the alluvial aquifer appeared to move to the northwest from the TNT Manufacturing Area to the Mill Creek drainage and to the southwest along the Oldtown Creek drainage after moving eastward to Oldtown Creek. Ground water recharging the alluvial aquifer in the relatively high elevations along the eastern edge of WVOW probably moves directly west to the Ohio River via Oldtown Creek. Recharged ground water in the high elevations west of the TNT Manufacturing Area may move directly west to the Ohio River.

D. SUMMARY OF SITE CHARACTERISTICS

The following conclusions are based on the analyses performed during the remedial investigation and is organized by area of concern within this second operable unit. Details of the contaminant distribution in each source area are presented in the RI/FS.

a. Acids Area/Yellow Water Reservoir

1. Contaminant sources were identified and include the sediments of the Yellow Water Reservoir and contaminated soil in the vicinity of the neutralization chamber.

2. Nitroaromatic contamination exists in the shallow aquifer. The contamination is limited in areal extent.

3. The gray clay confining layer is present at the Yellow Water Reservoir and acts as an effective barrier to vertical contaminant migration.

4. The contamination detected in the deep aquifer in April 1986 was attributed to shallow aquifer contamination being carried into the deep aquifer during drilling.

5. Ground water flow direction in the shallow aquifer is to the west; ground water flow in the deep aquifer is to the north.

b. Red Water Reservoirs

1. The source strength of the sediments of Pond 1 and Pond 2 was defined through the sampling and analysis of deep sediment cores. Low levels of nitroaromatics were detected in several of the deeper sediment samples.

2. Nitroaromatic contamination was detected in the shallow ground water but is present for the most part, at very low levels, (0.2 ug/L 2,4,6TNT); the downgradient limit of contamination is projected to occur at or immediately west of the reservoir area.

3. The gray clay confining layer present at the Red Water Reservoirs acts as an effective barrier to vertical contaminant migration.

4. The apparent low-level contamination detected in the deep aquifer in 1986 is attributed to shallow contamination being carried into the deep aquifer during drilling.

5. Ground water flow direction in the shallow aquifer is to the northwest; ground water flow in the deep aquifer is expected to have a northerly component.

c. Pond 13/Wet Well Area

1. The highest levels of nitroaromatics (principally 2, 4,6-TNT) occur in the shallow aquifer downgradient of the Wet Well Area and Red/Yellow water trunk sewer line.

2. The contaminant plume appears to be confined to the immediate vicinity of the two wet wells at the Pond 13 area.

3. The shallow sand aquifer appears to be areally limited and is bounded by clay-dominant sediments observed immediately to the north and to the east of the site.

4. The gray clay confining layer present at Pond 13 acts as an effective barrier to vertical migration.

5. Based on the water levels measured in the RI (ESE, 1986d) and supplemental RI (ESE, 1986a) essentially no direction of ground water flow can be established for the shallow aquifer.

6. The hydraulic head observed in the deep monitoring wells is higher than those observed in the shallow aquifer further substantiating the conclusion that vertical contaminant migration at Pond 13 is unlikely.

7. Although the substantial clay deposits below the contaminated shallow aquifer should constitute an effective barrier to downward contaminant migration, low levels of nitroaromatics were observed in the deep aquifer, however, that incidental contamination appears to be an isolated, localized occurrence.

E. SUMMARY OF SITE RISKS

Potential exposure pathways are as follows: at the Acids Area/Yellow Water Reservoir Area, the only significant pathway at present is direct contact with surficial soils. If the area is developed for industrial use in the future, it can be assumed that workers could be exposed to contaminated soils/sediments. On-site construction or landscaping activities could expose contaminated subsoils. At Pond 13, the exposure pathway of concern results from leachate generation by contaminated sediments in the wet wells, ground water transport in the shallow sand aquifer, and discharge via a small seep to Pond 13, where aquatic biota are exposed. Since Pond 13 is currently closed to fishing, aquatic biota are the only population exposed after bioaccumulation of contaminants from water or sediments.

Ground water resources that may have become contaminated are not now used for potable supply. The area is served by a municipal supply, and any new residents can be connected to this supply. However, they are not required to connect, and the ground water resource is a "usable" aquifer.

The institutional constraints that currently exist on site militates against the use of ground water on the McClintic Wildlife station as a potable supply. The State of West Virginia has incentive, intent, and authority (barring a national emergency, in which case the Army could take control of the property) to maintain the land in this use.

Health and environmental risks associated with exposure to site contamination have been evaluated, and in general, no population is currently being exposed to unacceptable levels of contamination. However, future populations might be at risk if land or water use changed and no remedial actions were taken. In consideration of this, the No-Action Alternative is not viable in any area included in the second operable unit. In the Acids Area/Yellow Water Reservoir, the carcinogenic risk resulting from occasional exposure to contaminated surficial soils under the existing land use is estimated to be less than 1.8×10^{-6}. If the area were developed industrially, the most probable future land use, workers could be exposed to DNT concentrations resulting in a 2.8×10^{-5} individual cancer risk. Furthermore, exposure to 2,4,6-TNT, noncarcinogenic contaminant, would exceed recommended exposure levels by a factor of 2.7. Surficial soil contamination in this area has resulted in adverse environmental impacts on vegetation as indicated by the lack of vegetation in a contaminated hot spot.

Levels of contamination in the surficial water table aquifer in the Acids Area/Yellow Water Reservoir exceed acceptable levels for drinking water. The shallow water table aquifer is not used as a potable supply anywhere in the vicinity of WVOW since the preferred ground water supply is the deeper sand and gravel aquifer. Contamination of the shallow aquifer theoretically represents an endangerment since there are no prohibitions or feasibility constraints against its use. As a practical matter, however, this contamination poses no risk to public health since there is no reason to believe that it would be used in the fure, given the tradional use of the deeper aquifer. The contaminated portion of the surficial aquifer is in an area developed for institutional and industrial use, which is unattractive for residential development. In the Red Water Reservoir Area, ground water used as a source of domestic supply is contaminated. Existing wells exhibit acceptable levels of contamination, and the ground water quality has apparently reached a steady-state (maximum) concentration, so existing water users are not at risk now or in the future. If new wells were installed in areas outside but near McClintic Wildlife Station, these new wells might be contaminated to unacceptable levels. The carcinogenic risk associated with exposure to the DNTs for a hypothetical new domestic well in the center of the plume at the McClintic Wildlife Station boundary could be as great as 4.8×10^{-4}, which is outside the acceptable risk range for CERCLA response actions. Risks due to noncarcinogenic contaminants and risks to nonhuman biota associated with the Red Water Reservoir Area are negligible.

Existing populations are not exposed to unacceptable levels of contamination in the Pond 13/Wet Well Area because Pond 13 is closed to fishing. If no remedial action were taken and Pond 13 were reopened for fishing, bass fishermen and others with whom they shared their catch could experience a cancer risk as high as 1.7×10^{-5} due to exposure to the DNTs. Exposure to noncarcinogenic contaminants and risks to aquatic biota are within acceptable limits in this area.

F. REMEDIAL ALTERNATIVES OBJECTIVES

The major objectives of remedial action to be taken at the West Virginia Ordnance Works Site include the removal of soil contaminants to protective levels; the minimization of the amount of hazardous substances leaching into the groundwater and the treatment of groundwater to protective levels. The levels that were developed are based on standards that were available for the specific chemical, or developed with respect to the 10^{-6} cancer risk, that is one person in one million adversely affected.

Based on the above objectives, numerous source control technologies were screened to provide a limited number of technologies applicable for remedial action at the site.

Table 4. Remedial Objectives for Second Operable Unit

Compound	Ground Water Used as Drinking Water Supply (ug/L)	Soils, Industrial Land Use (mg/kg)	Surface Water, McClintic (ug/L)
TNT	50	4,000	60
DNB	14	1,200	160
TNB	200	18,000	80
2,4-DNT			
10-6 Risk	0.11*	10	3.4
10-5 Risk	1.1	100	34
2,6-DNT			
10-6 Risk	0.022*	2	0.67*
10-5 Risk	0.22*	20	6.7
Total Nitroaromatics			
10-6 Risk	NA	200	NA
10-5 RISK		2,000	

*Below detection limit

G. DESCRIPTION OF ALTERNATIVES

1. Technologies Available

Each technology was evaluated not only in terms of theoretical feasibility, but also in terms of whether the technology is applicable to the site-specific conditions. The technologies for each of the three areas can be grouped into the following four categories:

1. Excavation and Incineration

2. Excavation and Landfilling

3. Containment and Institutional Controls

4. No Action

In an effort to provide a degree of flexibility in the final selection of a remedial action, a set of alternatives covering a range of remedial actions, based on the above technologies, has been developed. As specified by EPA policy and interim guidance on compliance with the NCP and CERCLA, as amended by SARA, remedial action alternatives were developed ranging from an alternative that eliminates the need for long-term management and monitoring to alternatives involving treatment to reduce toxicity, mobility, or volume. In addition to the range of treatment alternatives, a containment option involving little or no treatment and a no-action alternative were developed.

Table 4. Remedial Objectives for Second Operable Unit

Compound	Ground Water Used as Drinking Water Supply (ug/L)	Soils, Industrial Land Use (mg/kg)	Surface Water, McClintic (ug/L)
TNT	50	4,000	60
DNB	14	1,200	160
TNB	200	18,000	80
2,4-DNT			
10-6 Risk	0.11*	10	3.4
10-5 Risk	1.1	100	34
2,6-DNT			
10-6 Risk	0.022*	2	0.67*
10-5 Risk	0.22*	20	6.7
Total Nitroaromatics			
10-6 Risk	NA	200	NA
10-5 RISK		2,000	

*Below detection limit

Available remedial technologies identified and developed into alternatives for each area of concern, the source of the contamination in that area was initially addressed. Selection of the remedial technology for the source was based on the type, concentration, and extent of contamination in the source medium; knowledge of previous applications and performance of the remedial technologies; and knowledge gained from pilot-scale of field studies. Three broad categories were used for the evaluation: effectiveness, implementability and cost. The following is a summary of the evaluation for each area. The alternatives are fully summarized in Appendix A.

2. PRESENTATION OF ALTERNATIVES

I. Acids Area/Yellow Water Reservoir Alternatives

Alternative 1A (incineration and treatment) involves excavation of contaminated soil for off-site incineration and treatment by carbon adsorption of groundwater removed by extraction wells, followed by direct discharge to Mill Creek. The objective of this alternative with regard to soils is removal of contaminated soils that contain nitroaromatics with concentrations above acceptable levels. Groundwater will be treated to levels specified by applicable or relevant and appropriate requirements.

Alternative 2A (incineration and treatment) is identical to alternative 1A, except that incineration would be accomplished on site. A mobile incinerator would be transferred to the site and the ash by-product would be used for backfill. Groundwater would be treated to levels specified by applicable or relevant and appropriate requirements.

Alternative 3A (removal and disposal) involves the excavation of contaminated soils/sediments for disposal in an off-site landfill. Remedial action for contaminated groundwater involves pumping and treating, by by carbon adsorption to appropriate levels and direct discharge of the treated water to Mill Creek.

Alternative 4A (containment) involves purchasing the industrial park, which encompasses the area of contamination, adding 2 feet of soil cover over areas of contaminated soils, incorporating the area into the existing wildlife station and extracting and treating the groundwater in the manner previously described. The objective of this alternative is to eliminate the direct exposure pathway to contaminated soils.

Alternative 5A is the "No Action" remedial alternative included to establish present baseline site conditions. This alternative would not improve site conditions nor would it mitigate the migration of site contaminants.

II. Red Water Reservoir Alternatives

Alternative 2A (incineration and treatment) involves excavation of contaminated soil for on-site incineration and treatment by carbon adsorption of groundwater removed by extraction wells, followed by direct discharge to Mill Creek. The objective of this alternative with regard to sediments is complete removal of all contaminated sediments that contain nitroaromatics concentrations in excess of designated levels.

Alternative 3B (removal and disposal) involves the excavation of contaminated sediments for disposal in an on-site landfill. Remedial action for contaminated groundwater to specified levels is the same as previously described (pumping groundwater, treating by carbon adsorption and direct discharge). The objective of this alternative is complete removal of all contaminated sediments that contain nitroaromatics concentrations in excess of designated levels.

Alternative 4A (containment) would involve relocation of existing ponds, leveling and backfilling of the areas and capping with a clay layer to preclude infiltration into the groundwater of the shallow aquifer. Groundwater would then be extracted and treated to specified levels in the manner previously described. The objective of containment of sediment contamination is to eliminate further migration of contaminants into the groundwater.

Alternative 5A is the "No Action" remedial alternative included to establish present baseline site conditions. This alternative would not improve site conditions nor would it mitigate the migration of site contaminants.

III. Pond 13/Wet Well Area Alternatives

Alternative 1B (incineration and treatment) involves excavation of contaminated soil for off-site incineration and treatment by carbon adsorption of groundwater removed by extraction wells, followed by discharge to Mill Creek. The objective of this alternative with regard to soils is complete removal of all contaminated soils that contain nitroaromatics concentrations above acceptable levels.

Alternative 2C includes excavation of contaminated soils and sediments with subsequent disposal at an on-site landfill. Groundwater treatment would involve using an in situ activated carbon bed in the soil adjacent to Pond 13.

Alternative 3A (removal and disposal) involves excavation of contaminated soils/sediments for disposal in an on-site landfill and treatment of groundwater by use of extraction well pumping, carbon adsorption treatment and direct discharge into Pond 13.

Alternative 3B (removal and disposal) involves excavation of contaminated soils/sediments for disposal in an off-site landfill and treatment of groundwater by use of extraction well pumping, carbon adsorption treatment and direct discharge into Pond 13.

Alternative 4A (containment) would involve covering the wet wells with soil and treating groundwater in the manner previously described. The objective of this alternative is to eliminate all direct exposure pathways to humans and aquatic biota.

Alternative 4B would involve relocating Pond 13, and groundwater treatment through well extraction, carbon adsorption and direct discharge to a new Pond 13. The objective of this alternative is to eliminate all exposure pathways to humans and aquatic biota.

Alternative 5A is the "No Action" remedial alternative included to establish present baseline site conditions. This alternative would not improve site conditions nor would it mitigate the migration of site contaminants.

H. SITE SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d)(2)(A) of CERCLA, as amended by SARA, discusses cleanup standards applicable to any hazardous substance, pollutant, or contaminant that will remain on site. The selected remedial action must at least attain legally applicable or relevant and appropriate standards, requirements, criteria, or limitations (ARARs). These ARARs include Federal environmental laws including, but not limited to, the Toxic Substances Control Act (TSCA), the Safe Drinking Water Act (SDWA), the Clean Air Act (CAA), the Clean Water Act (CWA), the Marine Protection, Research and Sanctuaries Act (MPRSA), and the Solid Waste Disposal Act (SWDA). In addition, any promulgated state standard, requirement, criterion, or limitation that is more stringent than Federal requirements is applicable if such a state requirement is part of a Federally delegated program and has been identified to the President by the State in a timely manner. Pursuant to EPA guidance, a promulgated state standard is a standard that is generally applicable (i.e., not specific to a single targeted site or activity) and enforceable by the State (EPA, 1987). Nonpromulgated standards may be determined in considering the necessary level of cleanup. Accordingly, the major ARARs to be considered include:

Federal

Clean Water Act	- Wetlands Impacts - Differential Groundwater Policy - Ambient Water Quality Criteria - Pretreatment Standards for explosives Manufacturing Point Source Category - EPA National Pollutant Discharge Elimination System requirements
Resource Conservation and Recovery Act	- Groundwater Protection Standards

State

West Virginia Hazardous Waste Management Regulations	- Closure and Post Closure Standards - Standards for Owners and Operators of Hazardous Waste Treatment Storage and Disposal Facilities - Performance Standards for Incinerators - Groundwater protection standards

The ARARs identified for remedial actions are those selected from Federal and State environmental laws and standards that are applicable or relevant and appropriate to the site-specific remedial actins under consideration. These ARARs are contaminant-specific, location-specific and action-specific and are more fully addressed on the RI/FS.

a. CONTAMINANT-SPECIFIC ARARS

A contaminant-specific ARAR is a chemical-specific concentration limit established by either Federal or State environmental laws for a given environmental medium. Examples may include MCLs and maximum contaminant level goals (MCLGs) established pursuant to SDWA, ambient water quality criteria (AWQC) established pursuant to CWA, and national ambient air quality standards (NAAQS) established pursuant to CAA.

No numerical concentration limits for lead and nitroaromatics in soils and sediments currently exist in either Federal or West Virginia environmental regulations. However, West Virginia Hazardous Waste Management Regulations (Chapter 20-5E, Series XV) requiring closure of regulated units and the recent proposed RCRA amendments for landfill, surface impoundment, and waste pile closure (52 Fed. Reg. 8712) are relevant and appropriate. Both regulations were promulgated, in part, to protect

human health and the environment from contaminated soils and sediments upon facility closure.

Surface water contamination by nitroaromatics was identified in Pond 13. Numerical concentration limits for contaminants in surface water are found in AWQCs established pursuant to Section 304(a) of CWA. These criteria provide guidance on acceptable levels of contaminants in surface water for the protection of human health and aquatic life. AWQCs are not applicable, but they may be determined to be relevant and appropriate. AWQCs for contaminants of concern at WVOW serving as criteria for protection of human health include: lead, 50 ug/L; and 2,4-DNT, zero. The value for lead is also the MCL which is applicable to drinking water. It is not relevant and appropriate to surface waters at this site insofar as surface waters are not used as a source of drinking water. The AWQC for 2,4-DNT is not appropriate since it is not measurable and, thus, could not be enforced, nor is it technically feasible to achieve.

An AWQC has also been promulgated to protect aquatic life from exposure to lead. The criterion is hardness-based and may be relevant and appropriate. No numerical concentration limits for nitroaromatic compounds are included in West Virginia Water Quality Standards (West Virginia Administrative Regulations, State Water Resources Board, Ch. 20, Article 5).

For ground water contamination, potential contaminant-specific ARARs include MCLs, MCLGs, RCRA Subpart F regulations, West Virginia Hazardous Waste Regulations, West Virginia Water Quality Standards, AWQCs adjusted for drinking water, and Health Advisories released by EPA's Office of Drinking Water. To date, neither MCLs nor MCLGs have been promulgated for nitroaromatics.

RCRA ground water protection standards (40 C.F.R. Section 264.92 et seq.) were promulgated for the protection of potential drinking water sources from contamination released from hazardous waste facilities. These same standards are codified as West Virginia Administrative Regulations, Department of Natural Resources, Ch. 20-5E, Series XV, Sec 8.

West Virginia ground water protection standards identify three categories of ground water concentration limits: (1) MCLs. (2) background levels, and (3) alternate concentration limits (ACLs). As noted earlier, MCLs do not exist for nitroaromatics. Although background ground water quality data are available for WVOW, ACLs are permitted in lieu of background levels if these levels will not pose a substantial present or potential hazard to human health or the environment.

Contaminant-specific concentration limits and criteria based on the ARARs considered are presented in Table 12.

b. LOCATION-SPECIFIC ARARs

Location-specific ARARs are those requirements that establish restrictions on remedial activities or limitations on contaminant levels on the basis of site characteristics or the physical characteristics of the surrounding area. State locational requirements are to be followed only when they are of general applicability and are based on hydrogeological considerations. These requirements should not be intended to restrict land disposal for reasons other than protection of human health or the environment. Examples of such ARARs include siting laws for hazardous waste facilities, laws regarding development or other activities in wetlands and floodplains, historic preservation laws, and laws for the protection of endangered species.

There are several site characteristics that may require compliance with location-specific ARARs. A portion of the site is located in the floodplain of the Ohio River. Also, the site is a State wildlife management area.

Table 12 - Concentration Limits and Criteria Based on Contaminant-Specific ARARs for WVDW

Contaminant	Acids Area/Yellow Water Reservoir and Red Water Reservoirs Ground Water (mg/L)
TNT	50
DNB	14
TNB	200
2,4-DNT	
10^{-6} Risk	0.11*
10^{-5} Risk	1.1
2.6.DNT	
10^{-6} Risk	0.022*
10^{-5} Risk	0.22*

*Below analytical detection limit.

Note: DNB = dinitrobenzene.

Taking site conditions into account, location-specific ARARs for WVOW include West Virginia Hazardous Waste Management Regulations, Section 12, Location Standards of Hazardous Waste Management Facilities; Executive Orders 11988 (floodplains) and 11990 (wetlands) as implemented by EPA's August 6, 1985 Policy on Floodplains and Wetlands Assessments for CERCLA Actions; and Section 404 of the CWA and associated regulations.

c. ACTION-SPECIFIC ARARs

Action-specific ARARs are standards that establish restrictions or controls on particular kinds of remedial activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities as opposed to the specific chemicals present at a site. Examples of action-specific ARARs include closure regulations, incineration standards, and pretreatment standards for discharges to publicly owned treatment works (POTWs).

Because several different alternative actions are to be evaluated for WVOW, different action-specific ARARs will apply to the various alternatives. These action-specific ARARs do not in themselves determine the appropriate remedial alternative, but indicate the performance levels to be achieved by the alternative.

Although action-specific ARARs cannot be firmly established prior to identification of remedial alternatives, alternatives developed for the first operable unit provide an indication of action-specific ARARs that would apply. Preliminary action-specific ARARs are listed in Table 13, and criteria based on these ARARs are listed in Table 14.

Table 13 - Action-Specific ARARs for WVOW

Closure and Post-Closure Standards (West Virginia Hazardous Waste Management Regulations, Ch. 20.5E, Series XV, Sec. 8.6).

Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (West Virginia Hazardous Waste Management Regulations, Ch. 20.5E, Series XV, Sec. 8.10 Waste Piles and Sec. 8.11 Landfills).

Performance Standards for Incinerators (West Virginia Air Pollution Control Commission Administrative Regulations, Ch. 16-20, Regulation XXV, Sec. 6).

Petreatment Standards for explosives Manufacturing Point Source Category (40 C.F.R Part 457).

EPA National Pollutant Discharge Elimination System (NPDES) requirements.

Table 14 - Criteria Based on Action-Specific ARARs

Remedial Activity	Criterion
Incineration	99.99 percent Destruction efficiency
Effluent Discharge	
TNT	60 ug/L
DNB	160 ug/L
TNB	80 ug/L

I. COMPARATIVE ANALYSIS

1. Acids Area/Yellow Water Reservoir

Alternative 1A

The objective of this alternative with regard to soils is complete removal of all contaminated soils that contain nitroaromatic concentrations above the 10^{-6} risk levels (200 mg/kg) for off-site incineration. The estimated quantity of contaminated (>200mg/kg) soil is approximately 1,800 cubic yards (cy). This action would eliminate the exposure pathway of direct contact.

Ground water would be extracted and treated on site using a transportable carbon unit. The estimated volume of 450 million gallons of ground water would have to be pumped and treated. The estimated time to complete ground water treatment (at 150,000 gpd) would be 10 years. Treated ground water would be discharged to Mill Creek via the drainage feature which runs adjacent to the area. The carbon adsorption system is capable of reducing the nitroaromatic concentrations in the ground water from the maximum of 6ug/l detected beneath the Acids Area/Yellow Water Reservoir area to below both the drinking water limits and surface water criteria. When the concentration in the influent decreases below the ground water action level for all contaminants, operations would be conducted during and after remediation to ensure that public health would not be threatened.

Five year reviews would not be required after closure for this permanent remedy, as there would be a full reduction of toxicity, mobility and volume of contamination. The present worth of this alternative is $7.73 million.

Alternative 2A

Alternative 2A is identical to Alternative 1A except incineration takes place on-site instead of off-site. This alternative includes excavation of contaminated soils for onsite incineration and treatment by carbon adsorption of ground water removed by extraction wells, followed by direct discharge of treated water to the drainage feature adjacent to the north side of the site which flows into Mill Creek.

Implementation of this alternative is the same as that described for Alternative 1A except that contaminated soils would be incinerated on-site and the ash would be used for backfill. All necessary monitoring actions will be made of the entire incineration process. Ash would be stored temporarily until analysis for contaminants could be completed to determine if sufficient treatment has been provided. Ash that passes analysis would be replaced in the completed excavation, and ash that fails analysis would be reincinerated. Upon completion of incineration operations, the incinerator would be decontaminated and removed. Wastes generated during decontamination would be collected and transported to a licensed treatment facility for disposal. Five year reviews would not be required after closure for this permanent remedy, as there would be a full reduction of toxicity, mobility and volume of contamination. The present worth of this alternative is $1.927 million.

Alternative 3A

Alternative 3A involves excavation of contaminated soils/sediments and disposal in an off-site landfill. The landfill selected based on cost is Cecos International, located near Williamsburg, OH. Remedial action for contaminated ground water is the same as for previously described alternatives (pumping ground water, treating by carbon adsorption, and direct discharge).

Implementation for this alternative is the same as alternative 1A except that contaminated soil would be transported to an off-site, secure, RCRA-licensed landfill.

Five-year reviews would not be required after closure for this permanent remedy, as there would be a full reduction of toxicity, mobility and volume of contamination. The present worth of this alternative is $1.142 million.

Alternative 4A

Alternative 4A involves purchasing the industrial park, which encompasses the area of contamination, adding a 22 ft. impermeable clay cap over areas of contaminated soils, incorporating the area into the existing wildlife station, and extracting and treating ground water in the same manner as described for Alternative 1A. The land to be purchased consists of Parcels A through G as shown in Fig. 10. Applicable action-specific ARARs are the same as those for Alternative 1A.

Incorporation of the land into the wildlife station and addition ofa clay cap would create an impermeable barrier to water, thereby eliminating water infiltration and production of contaminated leachate and eliminating the direct contact exposure pathway to contaminated soils.

Mobilization for this alternative is similar to Alternative 1A except that contaminated surficial soils/sediments would not be excavated but would be covered. Soil for cover from a local off-site commercial source or from an area within McClintic Wildlife Station would be hauled to the site.

Implementation of this alternative differs from previously described alternatives in that following clearing and gradding, the surface of the site would be recontoured to promote surface water runoff. The soil would be placed in layers of 1 ft. or less and have a minimum total thickness of 2 ft. The top 1 ft. of soil would consist of loosely placed topsoil, which would be seeded and mulched as described previously.

Five year reviews would be required for the covered areas of the site, despite the full containment of contamination. The present worth of this alternative is $1.4 million.

No Action (Alternative 5)

No remedial actions would be implemented under Alternative 5 at the Acids Area/Yellow Water Reservoir. This alternative would not improve site conditions nor would it mitigate the migration of site contaminants. This alternative has been included to establish present baseline site conditions. Alternative 5 is not classified in the NCP as either a source control remedy or a management of migration remedy.

Alternative 5 would include a long-term monitoring program to provide information on the extent of contamination migration as a function of time. The monitoring program would include sampling and analysis of ground water. Existing on-site monitoring wells could continue to be used to monitor any future migration past the installation boundary toward potential human or environmental receptors.

This alternative does not address public health or environmental considerations, but it would provide a means to identify future problems. It could be implemented easily, and no capital costs and low O & M costs would be required. Five year reviews of monitoring data and site conditions would be required. The present worth of this alternative is $55,000.

2. RED WATER RESERVOIRS ALTERNATIVES

Alternative 2A

Alternative 2A involves the excavation of contmainated soil for on-site incineration and treatment by carbon adsorption of groundwater removed by extraction wells, followed by direct discharge to Mill Creek.

The objective of this alternative with regard to sediments is complete removal of all contaminated sediments that contain total nitroaromatic concentrations in excess of the criteria presented in Table 12. The estimated quantity of contaminated sediments is approximately 25,000 cy. Assuming a 25-percent swell factor upon excavation, approximately 31,250 cy of sediment would be incinerated on-site. This action would eliminate the source of contamination of the shallow aquifer and would limit the duration of ground water treatment. Ground water would be extracted and treated on-site using a transportable carbon unit.

Five year rreviews would not be required for this permanent remedy, as there would be a full reduction of toxicity, mobility and volume of contamination. The present worth of this alternative $18.318 million.

Table 12 Criteria for Sediments of the Red Water Reservoirs

Compound	PPLV (mg/kg)
TNT	0.4
DNB	0.02*
TNB	1.7
2,4-DNT	
10^{-6} Risk	0.0003*
10^{-5} Risk	0.003*
2,6-DNT	
10^{-6} Risk	0.00006*
10^{-5} Risk	0.0006*
Total Nitroaromatics	
10^{-6} Risk	0.006*
10^{-5} Risk	0.06*

*Below detection limit.

Alternative 3A

Alternative 3A involves excavation of contaminated sediments and disposal in an on-site landfill. Remedial action for contaminated ground water is the same as previously described (pumping, treating by carbon adsorption and direct discharge). Action-specific ARARs for this alternative are the same as Alternative 2A except that West Virginia Performance Standards for Incinerators do not apply. The objectives and remediation criteria for this alternative would be the same as Alternative 2A and would involve the same volumes and level of treatment.

Implementation of this alternative would be the same as described for Alternative 2A except that contaminated sediment would be transported to an on-site, RCRA-permitted landfill. Additional borrow material would be required to return the ponds to their original elevation.

Closure would include the removal of all temporary facilities, post-closure sampling and analysis of ground water, and postclosure landfill cover maintenance. The landfill site must e registered as a hazardous waste disposal facility with permanent land use restrictions. The soil would be seeded with native grasses for stability. All wastes from decontamination of equipment and personnel would be transported to a RCRA-permitted disposal facility.

Five-year reviews would be required for this alternative to evaluate the performance of the on-site landfill. No permits would be required for this onsite CERCLA remedial action in accordance with 40 C.F.R. Part 300, Vol. 50, No. 224, Nov. 20, 1985; however, the substantive requirements of ARARs would be met. The present worth of this alternative is $11.001 million.

Alternative 4A

The objective of containment of sediment contamination is to eliminate further migration of these contaminants into the ground water of the shallow aquifer. Although the sediments would not be removed to the levels presented in Table 12, the goal of eliminating source of contamination of the shallow aquifer and limiting the duration of ground water treatment would be achieved. Ground water extraction and treatment would satisfy the reponse objective that ground water at the McClintic Wildlife Station boundary and off-site be safe to drink.

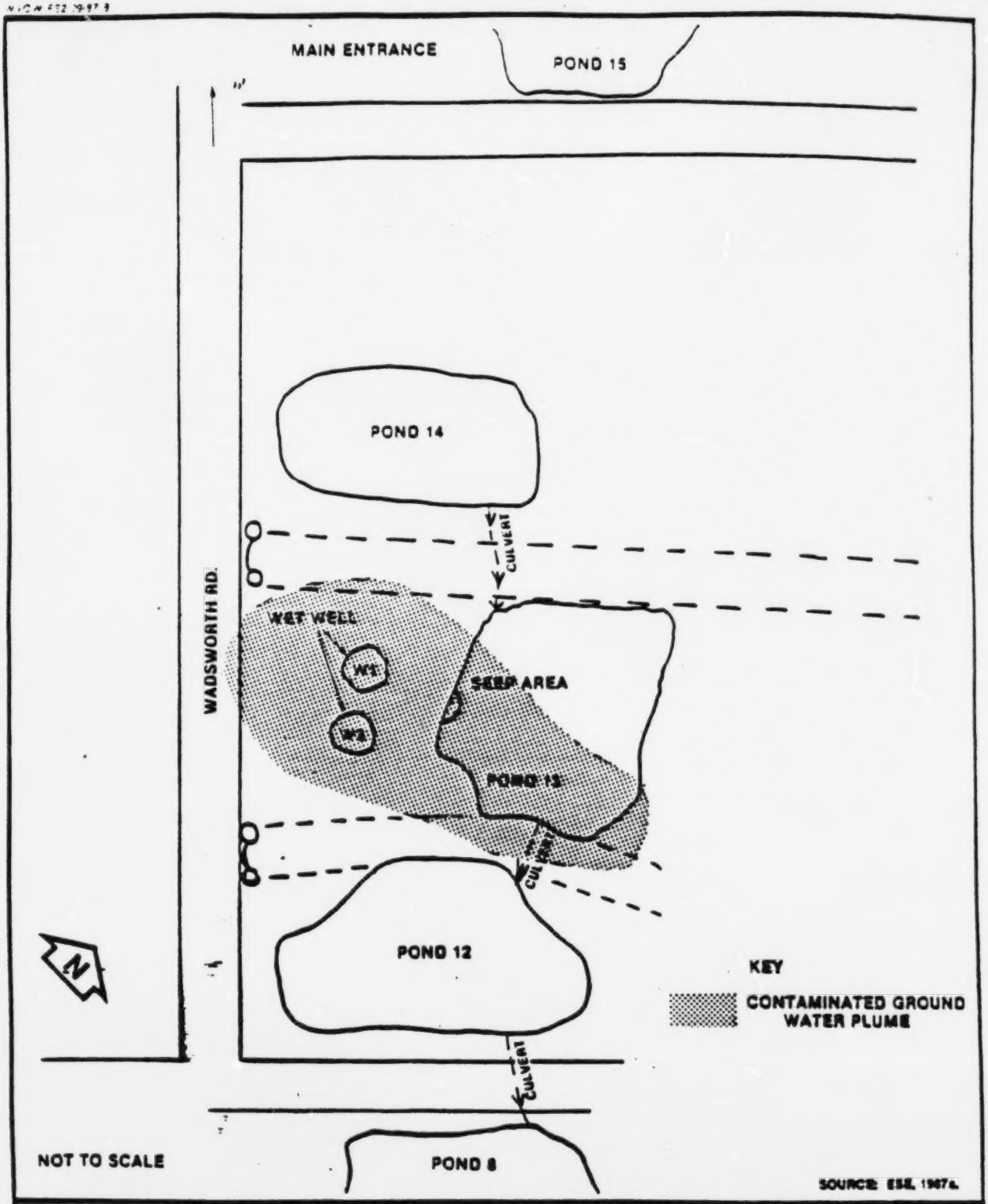

Figure 13
ESTIMATED AREA OF CONTAMINATED GROUND WATER — POND 13/WET WELL AREA

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

Implementation of this action would involve excavation of a nearby area, approved by the wildlife management personnel, and spreading a clay layer on the bottom and sides as a liner. The water from Ponds 1 and 2, which have been documented as not being contaminated, would be not pumped into the new pond area. Additional surface water sampling would be conducted to ensure that contaminated water is pumped to new ponds. The dewatered ponds would be leveled with local, compacted fill and graded to conform to the surrounding ground surface to promote runoff. A 2-ft layer of clay would be added in layers of 1 ft or less to the compacted and graded surface. The clay would be placed with sufficient moisture content to ensure that infiltration would be minimized. The compacted clay would be covered with 1 ft of topsoil, which would be seeded and mulched as described previously.

Five-year reviews would be required for the covered area of the site. No permits would be required for this on-site CERCLA remedial action in accordance with 40 C.F.R. Part 300, Vol. 50, No. 224, Nov. 20, 1985; however, the substantive requirements of ARARs would be met. The present worth of this alternative is $1.4 milion.

Alternative 5

Under Alternative 5, no remedial actions would be implemented at the Red Water Reservoirs. This alternative would not improve site conditions nor would it mitigate the migration of site contaminants. This alternative has been included to establish present baseline site conditions. Alternative 5 is not classified in the NCP as either a source-control remedy or a management of migration remedy.

Alternative 5 would include a long-term monitoring program to provide information on the extent of contamination migration as a function of time. The monitoring program would include sampling and analysis of ground water. Existing on-site monitoring wells could continue to be used to monitor any possible future migration of contamination past the installation boundary toward potential human or environmental receptors. The present worth of this alternative is $55,000.

II. POND 13/WET WELL AREA ALTERNATIVES

Alternative 1B

Alternative 1B would include excavation of contaminated soils and sediments for on-site incineration and treatment by carbon adsorption of ground water removed via extraction wells, followed by direct discharge to Pond 13.

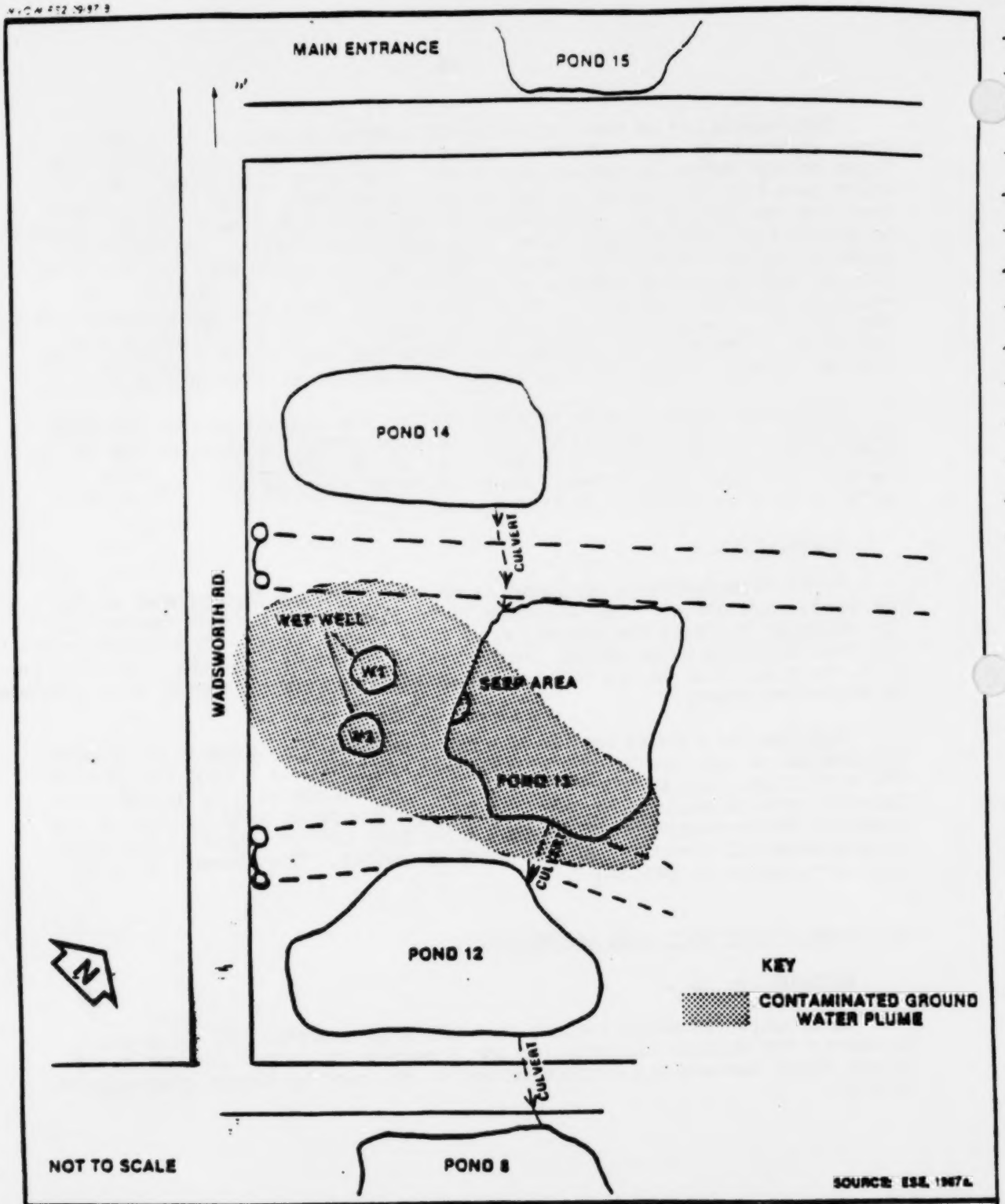

Figure 13
ESTIMATED AREA OF CONTAMINATED GROUND WATER — POND 13/WET WELL AREA

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

The objective of this alternative with regard to soils and sediments is complete removal of all contaminated material that contains total nitroaromatic concentrations exceeding the criteria for 10^{-6} risk level, and in accordance with Table 13. This action would eliminate the source of contaminated ground water which provides the conduit for contamination to reach Pond 13 and would limit the duration of ground water treatment.

Ground water would be extracted and treated on-site using a transportable carbon unit in accordance with the standards developed and listed in Table 14. Assuming an extraction/treatment rate of 150,000 gallons per day (gpd), the estimated time to complete ground water treatment would be at least 1 year. Treated ground water would be discharged to Pond 13.

Ground water monitoring would be conducted during and after remediation to ensure that public health would not be threatened. This action would eliminate the source of contamination for Pond 13 by satisfying the criteria presented in Table 14, which are a guide to achieving acceptable surface water quality in the pond. The present worth cost for this alternative is $4.62 million.

Alternative 2A

Alternative 2A on-site incineration and excacation and treatment of ground water. Ground water treatment involves using an *in situ* activated carbon bed in the soil adjacent to Pond 13 and would achieve levels in Table 14.

Ground water in the shallow aquifer would be treated *in situ* through the use of a bed of activated carbon. The nitroaromatic contaminants entering the bed of a would be removed by adsorption to the carbon, thereby preventing the continued deterioration of Pond 13.

Closure would include the removal of all temporary facilities, post-closure sampling and analysis of ground water, and post closure landfill cover maintenance. The landfill site must be registered as a hazardous waste disposal facility with permanent land use restrictions. The soils would be seeded with native grasses for stability. All wastes from decontamination of equipment and personnel would be transported to a RCRA-permitted disposal facility.

Five-year reviews would be required to evaluate the performance of the landfill and activated carbon bed. The present worth cost is $1.3 million.

Table 13 Criteria for Pond 13/Wet Well Area Sediments

Compound	PPLV for Wet Well Sediments (mg/kg)
TNT	15
DNB	8.0
TNB	20
2,4-DNT	
10^{-6} Risk	0.28
10^{-5} Risk	2.8
2,6-DNT	
10^{-6} Risk	0.056*
10^{-5} Risk	0.56
Total Nitroaromatics	
10^{-6} Risk	5.6
10^{-5} Risk	11

*Below detection limit.

Note: PPLV = preliminary pollutant limit value.

Table 14. Ground Water Criteria for Pond 13/Wet Well Area

Compound	PPLV (ug/L)
TNT	4,600
DNB	12,000
TNB	6,200
2,4-DNT	
10^{-6} Risk	260
10^{-5} Risk	2,600
2,6-DNT	
10^{-6} Risk	52
10^{-5} Risk	520

Alternative 3A

Alternative 3A involves excavation of contaminated soils/sediments for disposal in an on-site landfill and treatment of ground water by the use of extraction well pumping, carbon adsorption treatment, and direct discharge into Pond 13. Action-specific ARARs for this alternative include:

The objectives and remediation criteria for this alternative are the same as for Alternative 1B, and remediation would involve the same volumes and level of treatment.

Five-year reviews would be required for this alternative to evaluate the performance of the on-site landfill. No permits would be required for this onsite CERCLA action in accordance with 40 C.F.R. Part 300 Vol. 50, No. 224, Nov. 20, 1985. The present worth cost is $3.36 million.

Alternative 3B

Alternative 3B includes soil excavation with disposal in an off-site landfill and ground water treatment through well extraction, carbon adsorption, and direct discharge to Pond 13.

The objectives and remediation criteria for this alternative are the same as for Alternative 1B and would involve the same volumes and level of treatment.

This alternative is identical to Alternative 3A for the Acids Area/ Yellow Water Reservoir. Five-year reviews would not be required for this permanent action, as there would be a full reduction of toxicity, mobility and volume of contamination. The present worth of this alternative is $402,000.

Alternative 4A

Alternative 4A for the Pond 13/Wet Well Area would involve covering the wet wells with soil and treating the ground water through well extraction, carbon adsorption, and direct discharge to Pond 13.

The objective of this alternative is to eliminate all direct exposure pathways to humans and aquatic biota. The direct exposure pathways can be eliminated by covering the wet wells with 2 ft of soil and pumping and treating contaminated ground water before it enters Pond 13.

Five-year reviews would be required for this alternative to evaluate the performance of the covered site. The present worth cost is $565,000.

Alternative 4B

Alternative 4B for the Pond 13/Wet Well Area would involve relocating Pond 13 and ground water treatment through well extraction, carbon adsorption, and direct discharge to Pond 13.

The objective of this alternative is to eliminate all direct exposure pathways to humans and aquatic biota. The soil and ground water contamination is located below the ground surface; therefore, the ground water seep into Pond 13 represents the only direct contact exposure pathway. By relocating the pond, the elimination of existing exposure pathways is accomplished. A new pond would be excavated at McClintic Wildlife Station to maintain the current inventory of ponds at the refuge. Extraction and treatment of ground water would ensure that contamination would not affect Pond 14.

Five-year reviews would be required for the site. No permits would be required for this onsite CERCLA remedial action in accordance with 40 C.F.R. Part 300, Vol. 50, No. 224, Nov. 20, 1985; however, the substantive requirements of ARARs will be achieved. The present worth cost is $553,000.

Alternative 5

Under Alternative 5, no remedial actions would be implemented at the Pond 13/Wet Well Area. This alternative would not improve site conditions, nor would it mitigate the migration of site contaminants. This alternative has been included to establish present (baseline) site conditions. Alternative 5 is not classified in the NCP as either a source-control remedy or a management of migration remedy.

Alternative 5A would include a long-term monitoring program to provide information on the extent of contamination migration as a function of time. The monitoring program would include sampling and analysis of ground water, surface water, and seeps. Existing onsite monitoring wells could continue to be used to monitor any possible future migration of contamination past the installation boundary toward potential human or environmental receptors.

This alternative would not address the public health and environmental considerations, but it would provide a means to identify future problems; it can be implemented easily, and no capital costs and low O & M costs are required. Present worth cost is $77,000.

I. DOCUMENTATION OF SIGNIFICANT CHANGES

No changes to the preferred alternative presented in the proposed plan have occured.

J. SELECTED REMEDIAL PREFERRED ALTERNATIVE

1. Evaluation Criteria

Section 121 of as amended by SARA, and the current version of the NCP (50 Fed. Reg. 47912, November 20, 1985) establish a variety of requirements pertaining to remedial actions under CERCLA. The following nine criteria were used in the evaluation of the remedial action alternatives at WVOW.

- Overall protection of human health and the environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

- Compliance with ARARs addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes and/or provides grounds for invoking a waiver.

- Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

- Short-term effectiveness addresses the period of time needed to achieve protection, and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

- Cost includes estimated capital and operation and maintenance costs and net present worth costs.

- State Acceptance indicates whether, base on its review of RI/FS and proposed Plan, the State concurs on, opposes, or has no comment on the preferred alternative at the present time.

- Community Acceptance will be assessed in the Record of Decision following a review of the public comments received on the Administravite Record and Proposed Plan.

2. Determination of Preferred Remedial Alternative

EPA has made a preliminary determination that the preferred alternative provides the best balance of trade off with respect to the nine criteria. The preferred alternative is alticipated to meet the following statutory requirements to:

- Protect human health and the environment
- Attain ARARs
- Be cost-effective
- Utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable

In summary, at this time, the preferred alternatives are believed to provide the best balance of trade-offs among alternatives with respect to the criteria used to evaluate remedies. Based on the information available at this time, therefore, EPA believes the preferred effective, and would utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Accordingly, we recommend that the following alternatives be implemented.

a. Acids Area/Yellow Water Area

The preferred alternative for the Acids Area/Yellow Water Reservoir is Alternative 4A. This alternative consists of the purchase of lands within the area encompassing the contamination, placing 1 2-ft soil cover over the contaminated area, incorporating the area into the existing wildlife preserve, and extracting and treating the ground water.

This alternative provides protection of human health and the environment by containing the nitroaromatic contaminants in soils therefore protecting against exposure. Although residual contamination will remain in the soils, as long as the soil cover remains intact, exposure to humans via the inhalation, skin contact, and ingestion pathways will be mitigated. Further protection is provided through the purchase of the land and the control of the use of the lands by incorporating it as part of the wildlife preserve.

Through these institutional actions, development of the lands for industrial or residential use will be prohibited, and the contaminants will remain undisturbed.

The extraction and treatment of the ground water will mitigate this migration pathway and reduce the contamination in the aquifer. Potable water supplies will be protected through this action, and the local ground water will eventually be restored.

This alternative meets the contaminant, site, and action specific ARARs. Although contaminants are left in place, the redesignation of land use and the soil cover will meet the healthbased criteria developed for nitroaromatics in soils. The ground water will be treated until the criteria for nitroaromatics are attained. Discharge from the ground water treatment system will achieve the stream standard and will be monitored to assure compliance.

This alternative is cost-effective in comparison to the other alternatives evaluated. The capital cost of the alternative is about two-thirds of the cost of the next least costly acceptable alternative and has about the same annaual O&M cost.

This alternative, however, does not provide permanent removal or destruction of the contaminants that remain in the soils. Although, through the institutional controls and the soil cover, protection against a release which could be an endangerment is provided. The ground water treatment system, however, will provide permanent removal of the contaminant and restore the ground water resource over time.

b. Red Water Reservoirs

The alternative selected for the Red Water Reservoirs is the relocation of Ponds 1 and 2 and the extraction and treatment of ground water (Alternative 4A).

This alternative will provide protection of human health and the environment by containing sediment contamination and eliminating further contamination of the ground water aquifer via the sediments in the ponds. Not only will the ground water contamination pathway be mitigated, but exposure to the sediments will also be prevented once the ponds are filled with clean fill. The extraction system will remove contaminants from the ground water and act to improve the quality of the aquifer. This alternative is also beneficial as new ponds will be created to provide recreation and wildlife activities.

This alternative will achieve the contaminant-specific ARARs by mitigating the contamination pathway and treating the ground water until the standard is achieved. The effluent from the treatment system will meet the surface water criteria and will be operated and monitored to maintain compliance. The site-specific ARARs will be achieved through the replacement of the ponds and the eventual use of the ponds for recreation and the promotion of wildlife.

This alternative is cost-effective in that it meets the ARARs and response objectives for about one-sixth the capital cost of the next least costly acceptable alternative. The longterm O&M cost is similar to that for the other alternatives.

Although this alternative does not provide destruction or removal of the contaminants in the sediments, it does provide protection and the reduction of further aquifer contamination. The extraction and treatment of the ground water is a permanent treatment remedy and will eventually act to restore the ground water.

c. Pond 13/Wet Well Area

Alternative 4A, the covering of the wet wells with soil and treating the ground water with disposal in Pond 13, is the preferred alternative for the Pond 13/Wet Well area.

This alternative will provide protection of human health and the environment by cutting off the contamination pathway to the pond. this will prevent further contamination pathway to the pond. This will prevent further contamination of the pond and the exposure to humans and biota from contaminated water and sediment. Although contaminated materials will remain in the wet wells, the cover will protect against direct contact and the inflow of contaminated ground water. The extraction and treatment system will remove the contaminants from the ground water as well as control the migration pathway.

The ARARs associated with this site will be attained including the action-specific ARARs associated with the discharge of the treated effluent into the pond.

The capital and operating cost of this alternative is in the same range of other alternatives evaluated, but is at least as effective or more effective in protecting against exposure and in restoring the pond and the aquifer.

Although this alternative does not provide permanent destruction or removal of the contaminants in the wet wells, it does provide control of the release and does prevent exposure to the contaminants. The pond and the ground water resources will be protected and restored through this alternative. Because this remedy will result in hazardous substances remaining on-site, the five year facility review, pursuant to CERCLA Section 121(c) will implemented.

J. THE STATUTORY DETERMINATIONS

I. Protection of Human Health and the Environment

The selected remedy will reduce and control the nitroaromatic contamination at the Site which will ensure adequate protection of human health and the environment.

2. Attainment of ARARs

The selected remedy will effectively attain the applicable or relevant and appropriate requirements as set forth in Section H.

3. Cost-effectiveness

The selected remedy provides overall effectiveness commensurate to its costs such that it represents a reasonable value for the money.

4. Utilization of permanent solutions employing alternative technologies to the maximum extent practicable.

The selected remedy is the most appropriate solution for this operable unit and represents the maxiumum extent to which permanent solutions and treatment can be practicably utilized.

5. Preference for treatment as a principal element

The preference is satisfied since treatment of the principal threats were found to be practicable.

APPENDIX A

Table 15 Summary of Detailed Analysis of the Alternatives for the Acids Area/Yellow Water Reservoir

Alternative	Effectiveness: Protectiveness	Effectiveness: ARARs	Effectiveness: Reduction of MTV	Effectiveness: Reliability	Implementability: Technical Feasibility	Implementability: Administrative Feasibility	Implementability: Availability	Cost ($1,000): Capital	Cost ($1,000): O&M	Cost ($1,000): Replacement
1A Excavation Offsite Incineration Extraction Treatment	Provides short-term and long-term protection	Complies	Elimination of soils/ sediments; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Incinerators, equipment, and operators readily available	7,247	72.1	--
2A Excavation Onsite Incineration Extraction Treatment	Provides short-term and long-term protection	Complies	Elimination of soils/ sediments; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Incinerators, equipment, and operators readily available	1,444	72.1	--
3A Excavation Offsite Landfill Extraction Treatment	Provides short-term and long-term protection	Complies	Elimination of soils/ sediments; significant reduction in ground water	Uncertainties associated with land disposal	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Landfills, equipment, and operators readily available	929	72.1	--
4A Institutional Controls Soil Cover Extraction Treatment	Provides short-term and long-term protection Residuals remain	Complies	Reduction in mobility of soils/ sediments; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Equipment, and operators readily available available	665	72.9	--
5 No Action	No protection	Does not comply	No reduction in MTV	Not effective	Easy to implement, monitor, and maintain; additional actions required	Approvals difficult to obtain; little community support	Equipment, spare parts, and operators readily available for monitoring	15	--	665-7,247

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Table 15.. Summary of Detailed Analysis of the Alternatives for the Red Water Reservoirs

Alternative	Effectiveness				Implementability			Cost ($1,000)		
	Protectiveness	ARARs	Reduction of MTV	Reliability	Technical Feasibility	Administrative Feasibility	Availability	Capital	O&M	Replacement
2A Excavation Onsite Incineration Activated Carbon bed	Provides short-term and long-term protection	Complies	Elimination of sediments; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Incinerators, equipment, and operators readily available	17,586	73.0	--
3B Excavation Onsite Landfill Extraction Treatment	Provides short-term and long-term protection	Complies	Elimination of sediments; significant reduction in ground water	Uncertainties associated with land disposal	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Landfills, equipment, and operators readily available	3,488	85.0	--
4A Relocate Ponds Extraction Treatment	Provides short-term and long-term protection; residuals remain	Complies	Reduction in mobility of sediments; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Equipment, operators, and spare parts for O&M readily available	683	73.0	--
5 No Action	No protection	Does not comply	No reduction in MTV	Not effective	Easy to implement, monitor, and maintain; additional actions required	Approvals difficult to obtain; little community support	Equipment, spare parts, and operators readily available for monitoring	15	--	528-17,586

Table 15. Summary of Detailed Analysis of the Alternatives for the Pond 13/Wet Well Area

Alternative	Effectiveness				Implementability			Cost ($1,000)		
	Protectiveness	ARARs	Reduction of MTV	Reliability	Technical Feasibility	Administrative Feasibility	Availability	Capital	O&M	Replacement
1B Excavation Onsite Incineration Extraction Treatment	Provides short-term and long-term protection; uncertainties with landfill	Complies	Elimination of soils/ sediments; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Incinerators, equipment, and operators readily available	358	70.2	--
2C Excavation Onsite Landfill Activated Carbon bed	Provides short-term protection; long-term uncertainties with landfill and carbon bed	Complies	Elimination of soils/ sediments; significant reduction in ground water	Long-term uncertainties with landfill and carbon bed	No technical limitations; easy to implement, monitor, and maintain	Approvals not easily obtained; well received by community	Equipment, operators, and spare parts for monitoring readily available	422	0.7	--
3A Excavation Onsite Landfill Extraction Treatment	Provides short-term protection; long-term uncertainties with landfill	Complies	Reduction of soils/ sediments; mobility and significant reduction in ground water	Uncertainties associated with land disposal	No technical limitations; easy to implement, monitor, and maintain	Approvals not easily obtained; well received by community	Equipment, operators, and spare parts for monitoring readily available	216	70.9	--
3B Excavation Offsite Landfill Extraction Treatment	Provides short-term protection; long-term uncertainties with landfill	Complies	Reduction of soils/ sediments; mobility and significant reduction in ground water	Uncertainties associated with land disposal	No technical limitations; easy to implement, monitor, and maintain	Approvals not easily obtained; well received by community	Landfills, equipment, and operators readily available	282	70.2	--

Table 15. Summary of Detailed Analysis of the Alternatives for the Pond 13/Net Well Area (Continued, Page 2 of 2)

Alternative	Effectiveness				Implementability			Cost ($1,000)		
	Protectiveness	ARARs	Reduction of MIV	Reliability	Technical Feasibility	Administrative Feasibility	Availability	Capital	O&M	Replacement
4A Soil Cover Extraction Treatment	Provides short-term and long-term protection; residuals remain	Complies	Limited reduction of soil mobility; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Equipment, operators, and spare parts for O&M readily available	250	70.6	--
4B Relocate Pond Extraction Treatment	Provides short-term and long-term protection; residuals remain	Complies	Limited reduction of soil mobility; significant reduction in ground water	Proven effective	No technical limitations; easy to implement, monitor, and maintain	Approvals easily obtained; well received by community	Equipment, operators, and spare parts for O&M readily available	239	70.2	--
5 No Action	No protection	Does not comply	No reduction in MIV	Not effective	Easy to implement, monitor, and maintain; additional actions required	Approvals difficult to obtain; little community support	Equipment, spare parts, and operators readily available for monitoring	17.3	--	147-1,274